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A WELCOME TO NEW YORK.

It is now just three years since the National Electric Light Association convened in this city. At that time the body was by no means as strong, nor were its prospects by any means as bright, as at present. The meeting held here in August, 1885, was the second, the first having been called in Chicago; and the young association had still to show that it could do a useful work and that there were good reasons for its existence. To-day, with a record of three years behind it, the Association can claim recognition as a success on the highest grounds, and it comes back to New York in greater vigor and prosperity than it has ever enjoyed before. The period that has elapsed between the two meetings in this city has been an eventful one. The electric lighting industry has undergone many changes. There has been a rapid extension of the use of the electric light, and one feature of that development has been the greater favor shown towards the light by the gas companies, which have themselves, in a large number of instances, become vendors of it. In the same period, too, a great many cities have invested in electric lighting apparatus for their streets. Since 1885, also, it has become the practice of electric lighting companies to pay attention to the demand for incandescent lighting, with the result that we now rarely find a local arc company that does not supply both kinds of light. In this connection must be noted the extraordinarily rapid introduction and development of the alternating system for incandescent lighting, and it is specially to be borne in mind that this new departure has largely been in the hands of the arc companies, many of which thought in 1885 that their sole duty and business lay in supplying outside arc lights for streets and stores. Yet another extension of the work has been found in the introduction of the electric motor. In 1885 there was practically no electric motor industry in this country, and the Daft Company was the only corporation in the world that was seriously paying attention to this business. To-day the local electric lighting companies have supplied thousands of motors, and are now furnishing current to them by night and day for the most varied purposes; while the questions connected with the supply of current for power have become as important as those connected with the supply of current for lighting. As we look back on the three years, all these various evolutions are seen to be fairly well defined, but as each came up no one was conscious at the time of the importance of the change. The advance and the growth have indeed been great, and they who have taken part in it and who have been connected with the work of the Association from the outset, may well congratulate themselves on the improvement and prosperity of the three years. It must be apparent to all, even to the sharpest critics, that the electric lighting business in America has passed from the early experimental and tentative stages to those in which it has the fullest claim to be classed among the leading progressive industries of the country.

The one point that arrests attention amidst all this development is that which has to do with the character of the installation and equipment. It goes without saying that where the growth has been at such a tremendous rate, much of the work has necessarily been crude and incomplete, and has been done by men who were not competent to make the plants thoroughly safe and satisfactory so that they could endure the test of time. It was thus in the telephone industry, and the evils of hasty work that have been noted and slowly cured by our telephonic friends are still those to be rectified in the field of electric lighting. Now that the National Electric Light Association is so well established and its authority is so well recognized, it cannot, we venture to believe, do better than in insisting upon the necessity of good and perfect work in the installation of plants and the construction of lines, whether overhead or underground. We have been delighted to notice, as a first practical step in this direction, the move taken by the New England Electric Exchange, which with its system of licensing for qualified men, bids fair to secure incalculable benefits for the industry in the New England States; and we would like to see the National Electric Light Association set the seal of its approval on the work done there, and if possible give extension to that work in other parts of the country where it is badly needed. The advantages of the electric light and of electric power are now well known, and all that is wanted is to minimize as far as may be the disadvantages which arise from slipshod installation and imperfect construction. In one way or the other this matter has been before the Association for the last two or three years; but it cannot be said that up to the present time the Association has taken any positive action outside the reading of papers and discussions thereon, to promote this desirable improvement in the quality of the work. It may appear to some that practical reform of this nature lies beyond the province of the Association. We do not think so, and shall be only too glad to lend our aid to the organization in raising the standard of efficiency and in suppressing the abuses which we all know to exist. Each local company will be the stronger in its own territory for any joint action that the Association make take, aiming at a higher quality of work and insisting on greater qualifications on the part of the men employed.

Of course, it will not all be hard work during the current week. The Association has always shown itself quite able to blend toil and pleasure judiciously, and we are sure that the city will not be found wanting in opportunities of relaxation and amusement for the visitors to the convention. The occasion is an unusual one, and we have no doubt that the hospitality of the city will be adequate and generous. We are glad to bid the delegates welcome to our city, and trust they will return to their homes in every way benefitted by their attendance at the meeting and their participation in such festivities as the occasion may give rise to.

Primary Batteries. WE have already stated elsewhere on this page that with the best conditions of working clearly understood, the primary battery may still hope to enter on a larger sphere of usefulness than it has heretofore occupied, and confirmations of this fact seem to be accumulating daily. Thus on another page Prof. A. E. Dolbear draws attention to a cell of exceptionally high E. M. F., whose efficiency, he states, is effected by means of very familiar chemicals. And he says truly that those who criticise primary batteries, or, in fact, scientific matters generally, should limit their conclusions to their actual data. By this means much hardship will be prevented in the case of those whose work in this field deserves consideration, and who would otherwise cease their labors for want of encouragement.

Incandescent Lamps as Converters of Energy. THE paper read by Prof. Ernest Merritt, at the meeting of the American Association for the Advancement of Science, brings us back to the old question of the relative efficiency of the incandescent lamp as a converter of heat energy into that of light. In his experiments with the ordinary 16 c. p. lamp, only from 4 to 6 per cent. of the energy expended in the lamp is available as light, the rest being dissipated as heat. While this is a good showing compared with the relative light efficiency of some other forms of illuminants, it still remains to find a means of increasing this factor, or in other words, of providing a filament for the incandescent lamp which may be driven to a far higher point of incandescence without too greatly affecting its life. Progress in this direction is steadily going on, but there is still so much to be done that the work may be considered as hardly begun. There is nothing theoretically which stands in the way of obtaining 20, 25, or 40 lamps per h. p., where to-day we only get 10.

"Electrical World" Portraits. WE present this week as the second in our series recently begun, the portrait of Prof. Elihu Thomson, and in connection therewith give a biographical sketch of that well-known electrician, of whom it may be affirmed that no one of prominence in the electrical profession more thoroughly enjoys the esteem and respect of his fellows. Prof. Thomson, it will be seen, is still a young man, and may be said to have the best part of his career before him, yet he has already done work that will live, and his name will be handed down to posterity with those of Edison, Brush, Weston, Swan, Gramme and other founders of the modern science and industry of electric lighting. It is somewhat singuler that one who had such marked success as an educator should have been able so readily to transfer his energies from the department of instruction in physical matters to that in which the most exacting conditions of practical work have to be met. There are very few men who can make this change with any degree of success, and the only similar case that we can recall is that of Prof. Anthony. We should be inclined to regard such men as Profs. Thomson and Anthony as ideal instructors in physics and allied studies, and still it is easy to understand the promptings which have led them into the field of practical electricity as that in which they can best do their life's work. We feel sure that all our readers will turn with interest to the sketch given of Prof. Thomson's career, and that many of them will prize his portrait as that of one whom to know is to admire.

Performance of Primary Batteries. IT is so rarely that reliable figures can be obtained upon the performance of the primary battery, that the article appearing in another column giving the results of a number of battery tests will be of undoubted interest to many of our readers. Mr. Kennelly has evidently bestowed great care upon these tests, and his results demand attention in more than one particular. They show, in the first place, that, depending on the material employed, and the internal arrangment of the battery, the cost of producing a given amount of electrical energy may vary considerably; and again, as has been frequently pointed out, unless special precautions are taken the number of cells required to furnish a given horse-power for any given length of time may be simply enormous. But, on the other hand, it is most gratifying to see that a primary battery can be produced which, with a reasonably long life, may be depended upon for an actual efficiency of 86 per cent. This confirms the statement made by Mr. F. B. Crocker, in his paper read before the American Institute of Electrical Engineers, that the principle of the primary battery itself is not at fault, but that it has been handicapped by the arrangements employed to effect the conversion of chemical action into electrical. With such tests before us, and with an intelligent appreciation of the requirements of the subject, the worker in the field of primary batteries ought not to be discouraged, notwithstanding the many failures of the past. It must never be forgotten, however, that a definite equivalent of zinc is required to be dissolved in order to obtain a given amount of electrical energy; and it is when this fundamental principle is lost sight of that costly mistakes and claims are frequently made which are not warranted by the results of earlier tests. It will be noticed that these tests were all made on a continuous run. It would be interesting, however, to know the result of a test in which the batteries are used intermittently, and allowed to recover at intervals.

"ELECTRICAL WORLD" PORTRAITS.—II.

ELIHU THOMSON.

Those who are familiar with the work of Prof. Elihu Thomson, and who believe in the principle of heredity, will not be surprised to learn that the chief family attribute on his father's side was the possession of mechanical insight and skill. Some of the members of the family were exceptional for their ability as skilled mechanics; and the same thing is true, though to a less extent, of his connections on the mother's side. "I love a smith's shop and anything relating to smithery," wrote Faraday once in his journal, "my father was a smith;" and here again we have a notable example of inherited tastes of the same nature. Elihu Thomson was born at Manchester, England, in 1853, his father being Scotch purely and his mother English, with a French admixture two generations back. In 1858, his parents crossed the Atlantic and settled in Philadelphia. Young Thomson had already, from his earliest remembrance, taken great interest in machinery and its operation, and liked to draw, even before the constructive or creative instinct had manifested itself. At seven he entered school in Philadelphia, and it was not long before he was ready to begin studies in the Central High School, but the age limit there being thirteen he had to wait nearly two years. This period of enforced idleness, which in many cases might have had unfortunate results, was just the opportunity the boy wanted, and it shaped his career for life. He had been building models of pumps, etc., and dabbling in photography, but he happened at this time to have given him a book describing experiments in electricity and telling how to make an electric machine with a wine bottle for a friction cylinder. He had never seen any such apparatus, nor had he more than the usual distant acquaintance with the electric spark, as seen in the lightning; but the machine was immediately built, and its construction was followed by work on Leyden jars and other statical appliances mentioned in the simpler text-books of those days on natural philosophy. Tobacco tinfoil, scraps of gold leaf and elder pith were great treasures, and the quest for elder bushes involved the trudging of many a weary mile into the country around Philadelphia. About the same time, too, a Morse telegraph circuit was made, complete, with instruments, batteries, etc., and the magnets were wound with wire, every inch of which was insulated by wrapping cord around the bare copper. Insulated wire he had never seen.

As may be imagined, much was learned from all this crude experimenting, and on that old classic ground of electricity the fascination of our noble science was once more exerting itself irresistibly. By the time he had finished his four years' course at the Central High School, Elihu Thomson may be said to have mastered a considerable part of what was known of electricity, and his continued experiments in that branch, as well as in chemistry, had fitted him to take a share in the coming development. On leaving the High School he spent about six months in an analytical laboratory in Philadelphia, testing iron ores, etc., but he was recalled to fill the place of assistant in the Chemical Department of the School. This position, which gave him charge of the chemical laboratory and apparatus, and the conduct of the instruction there, he filled until 1876, being meantime—in 1875—appointed Professor of Chemistry in the Artisans' Night School of Philadelphia, where, following a practice begun some years before, he delivered lectures on appropriate scientific topics. Through all this period his leisure was filled with a variety of work that has since proved of the greatest value, giving clues to unfamiliar methods, and leading to the invention of devices and tools that were specially needed. He became interested, for example, in organ construction, and built a pipe organ with four sets of pipes, and with electro-pneumatic key action. For this he made most of the zinc and wood pipes, the keys, valves, sound-board, bellows and other parts. Another hobby was lathe work in metal; and, this being insufficient to exhaust his energies, he took up lens grinding and speculum work, and built a compound microscope with his own hands, including compound achromatic object glasses, eye pieces, condensers, etc. This again was supplemented by work on photographic lenses and glass specula, and, it goes without saying, by the construction of numerous electrical devices, ranging from a glass plate Holtz machine to dynamo-electric machines.

Promotion, and that speedy, was inevitable in the case of such a worker, and in 1876 Professor Thomson, only twenty-three years old, was appointed to fill the chair of chemistry and physics at the Central High School, having charge of the chemical course of two years, and of the teaching in mechanics and in the properties of solids. Professor Houston had, as he still has, charge of the teaching in the other departments of physics. This professorship was held until 1880, when its incumbent resigned to take the position of electrician to the American Electric Company, of Connecticut, located at New Britain, and now the well-known Thomson-Houston Electric Company, of Lynn, Mass. During its term, however, Prof. Thomson was appointed lecturer at the Franklin Institute, in 1876-7, and gave courses on electricity, etc., that winter, as well as subsequently. All such lectures were illustrated by experiments with apparatus, often of original design and frequently of his own construction. For the course of 1876-7 he built his first practical dynamo, making patterns, winding, etc., of sufficient size to run a small arc lamp. No other such machine was available at the Institute at that time, and this contained several features afterwards found in a number of other dynamos. His genius had now struck into the right channel, and every minute that could be spared was given to experiments with dynamos and lamps. About the same time, however, certain observations on centrifugal action arrived at in teaching his classes as to the nature of centrifugal force, led him to work out, in conjunction with Professor Houston, a machine for the perfectly continuous centrifugal separation of substances of different densities. The machine, or process, was particularly applicable to cream separation from milk, and being patented, has gone into extensive use in creameries.

In the winter of 1877-8, Prof. Thomson served with Prof. Houston on a committee of the Franklin Institute on dynamo-electric machines. A number of dynamos were tested and the results were duly published. Their report emphasized the advantages of thorough lamination of armature cores, and pointed out the economy of working with a high external, as compared with the low internal resistance of the dynamo. Many other considerations of value were brought out in this report, and for the first time. In 1878, Prof. Thomson visited the Paris Exhibition, and studied specially the various electrical exhibits, including the Jablochkoff lighting system, which was then attracting much attention. He returned to America with renewed enthusiasm and industry to prosecute his own work, and in 1878 and 1879 he applied, jointly with Professor Houston, for a number of patents on electric lighting apparatus. These formed the nucleus around which the system of the American Electric Company of New Britain was built up, but before that company's organization Mr. Geo. S. Garrett, of Philadelphia, built several of the machines and lamps under license, and put the plants in operation.

Upon resigning his professorship, as above noted, and assuming the duties of electrician to the new company, Prof. Thomson removed to New Britain, and joint work with his old colleague and associate ceased. The transition from scholastic and educational duties to those of an inventive and executive order in a great industrial establishment is not one that very many men can make easily or with success, but Prof. Thomson was not less at home among the machinery of a novel and bustling enterprise than he had been with his classes in the quieter academic surroundings of Philadelphia. He now gave his whole time to electrical work, arranging all the details of design and manufacture, and it was soon his good fortune to become associated with the excellent business management which has given the Thomson-Houston Electric Company its splendid position in the foremost rank of electrical industries, and has won for the system not only universal adoption in this country, but the highest reputation abroad. In 1883, the removal of the Thomson-Houston Company to Lynn was attended by a great extension of the business, with renewed and exacting demands on Professor Thomson's time and powers. The varied undertakings of the company in arc lighting, incandescent lighting, motor work, induction systems, etc., stand as a partial representation of such work, and as an exemplification of the ideas and ingenuity embodied in well nigh 200 United States patents, more than 150 of which have been taken out since the old Philadelphia days. Many applications are still pending in the Patent Office, and much work naturally remains, full of promise though not submitted to the public eye, in the private sketches, note books, drawings, experiments and models of apparatus, that have accumulated during the past eight years of growth. Prof. Thomson's ability as an inventor has of late, too, found its expression in his admirable system of electric welding, the exploitation of which is in the hands of the Thomson Electric Welding Company, and the devising of new apparatus to render the method generally available has occupied much of his time, with the result that electric welding has now its distinctive place among the arts. It should be mentioned here that in the midst of all these cares and responsibilities Professor Thomson has enjoyed the help of Mr. E. W. Rice, Jr., who, having as a pupil finished his High School course in 1880, accompanied Professor Thomson to New Britain, and was for several years his assistant. Mr. Rice, who is now superintendent of the works of the company, has taken an active part in inventing, designing and planning from the outset, and has done work of the greatest value to the company's enterprises.

Up to 1880, and while associated with Prof. Houston at the Central High School, Prof. Thomson contributed notes and papers quite freely to the scientific journals, but it will be seen that at present, with his innumerable other calls, that relaxation can be indulged in bu occasionally. The wear and tear of daily work is a sufficient demand on time and energy, but he has nevertheless made one or two notable efforts in this direction. A paper read by him on electric welding before the Boston Society of Arts in 1886 appears to have been more widely copied, and in more languages, than any other scientific essay of that period. A timely report on insulation and installation of electric light plants was placed a few months ago before the National Electric Light Association, and a paper read before the American Institute of Electrical Engineers on "Novel Phenomena of Alternating Currents" in 1887, is regarded as one of the most striking and permanently valuable contributions to the literature of the subject. Prof. Thomson is a charming extemporaneous speaker, his grasp of the theme and his command of clear, terse yet graceful English rendering his addresses a source of extreme pleasure to all who hear them. In all that he says or does, the same quiet dignity and modesty of bearing are seen.

Prof. Thomson is a member of the American Philosophical Society, the Franklin Institute, the Society of Arts, Boston, the American Academy of Arts and Sciences, and the American Association for the Advancement of Science. He has lately been elected to a second term as Vice-President of the American Institute of Electrical Engineers, and is an honorary member of the Boston Electric Club. Prof. Thomson was married in 1884 to Miss Mary L. Peck, and has two sons.

The Moebius Electrical Process for Refining Silver.

For several years, says the *Engineering and Mining Journal*, Mr. B. Moebius has been laboring assiduously to perfect his process for the electrical separation of gold and silver, which has now been put into practical operation, with excellent results.

The principle upon which the process depends is that when silver to be refined is made the anode in a weak nitric acid bath, the silver will pass into solution as nitrate through the action of an electric current, and will be redeposited in the metallic state upon a silver plate which constitutes the cathode. In practice the base bullion is cast in plates ½ inch thick and about 14 inches square. These plates are inserted in muslin bags intended to retain the gold, platinum, lead (as peroxide) and other metals remaining after the silver is dissolved out, and are suspended in the tank of acid from copper rods. Alternating with these are the silver plates for the deposition of the refined silver. The current is 150 ampères, and one volt to each tank. The tanks can be arranged in plain series or in multiple arc at will. In each tank is a tray for catching the silver as it is scraped from the cathodes by automatic brushes, which move constantly back and forth across the plates, thus preventing the silver from accumulating and forming a connection with the anodes. For convenience in cleaning out the trays, they are arranged so as to admit of being hoisted out of the tanks, and the bottom of each is divided in the middle and hinged to the sides of the frame, so that upon removing a silver pin these sections swing down and outward, dropping the silver into tubs placed underneath. The bath contains no more than one per cent. of nitric acid, and will not, for a very considerable period, produce any noticeable effect upon the muslin bags. Under the influence of the electric current the silver rapidly dissolves, and any copper in the bullion is dissolved also, but remains in solution. The process is peculiarly adapted to refining Doré silver, which contains about 800 silver and 100 of gold.

A small working plant on this system has been put in operation in this city. It is claimed that refining by this method can be done in New York for three-fourths of a cent per ounce, while the minimum charge that will leave a profit to the refiner using other methods is one cent per ounce.

Jointing Phosphor-Bronze Wires Without Heat.

The following abstract from the *Electrotechnische Zeitschrift*, part 4, 1888, is given in the *Journal of the Society of Telegraph Engineers and Electricians*, upon a method for jointing phosphor-bronze wires without any application of heat: "It is very desirable to avoid by all means the heating of phosphor-bronze wires, as this leads to a decrease of the breaking strain, and consequently some means of jointing had to be sought for which might replace the method of soldering used for iron wires. Moreover, experience has shown that some local action is set up between the tin solder and the iron wires, which in time leads to a weakening of the joint; such action would of course be still greater with phosphor-bronze wires, owing to the greater affinity of tin and copper. The best substitute for solder is a copper amalgam prepared as follows: Freshly precipitated copper oxide is heated in a tube in a stream of hydrogen until it is reduced to metallic copper. When thoroughly cooled, this fine copper powder is moistened with dilute sulphuric acid and well mixed with mercury, and is then washed. A simpler plan, though not such a good one, is to obtain the copper powder by reducing copper sulphate by means of metallic zinc. In making use of this amalgam for jointing wires, it is pressed closely round them and allowed to set. On this account a twisted joint is not very well adapted; a Britannia joint is better, as the amalgam penetrates inside the binding wire. But the best joint is made with a tube connection, the two ends of the wires being turned up at not too sharp an angle and secured with binding wire; the amalgam is then pressed well into the tube, where it sets quite hard."

The Plant of the Colorado Electric Company at Denver, Colo.

At the present time, nothing will more readidly convince one of the enterprise and thrift of a city than by observing the number of electric lights it is using. This is especially the case in the West. Few people in the East have any appreciation of the extent to which this popular illuminant is adopted, for example, in the heart of the Rocky Mountains; hence a sketch of the electric lighting industry in Denver may be of interest.

Denver was one of the first cities in the Union to adopt the central station method of electric lighting. The Colorado Electric Company was organized in 1880, using the Brush system and starting with a capacity of 200 arc lights. This was all commercial lighting, and but a short time elapsed before a contract from the city was secured to light the suburbs by the "tower system," for which seven iron towers 150 ft. high were erected, each carrying six 3,000 c. p. arc lights. In 1885 the contract of the gas company for lighting the city lamp-posts expired, and new bids were called for. The Colorado Electric Company was successful in securing the contract to light the city, replacing each gas jet with a 20 c. p. incandescent lamp, a thing the gas company at the time thought impossible, as, having no competitors in their own commodity, they did not attempt to alter their old price. This contract was recently renewed for five years, so to-day the city is using 900 incandescent lamps on its streets as well as a large number of arc lights, lighting districts so remote that it will be years before the gas company can cover this territory with their mains. For this work the Edison municipal system is used, which with its many improved appliances for controlling the current on the giving out of a lamp, and the readiness with which the city can be lighted on the approach of a sudden storm obscuring the moon, has been found to be a most successful plan for city lighting.

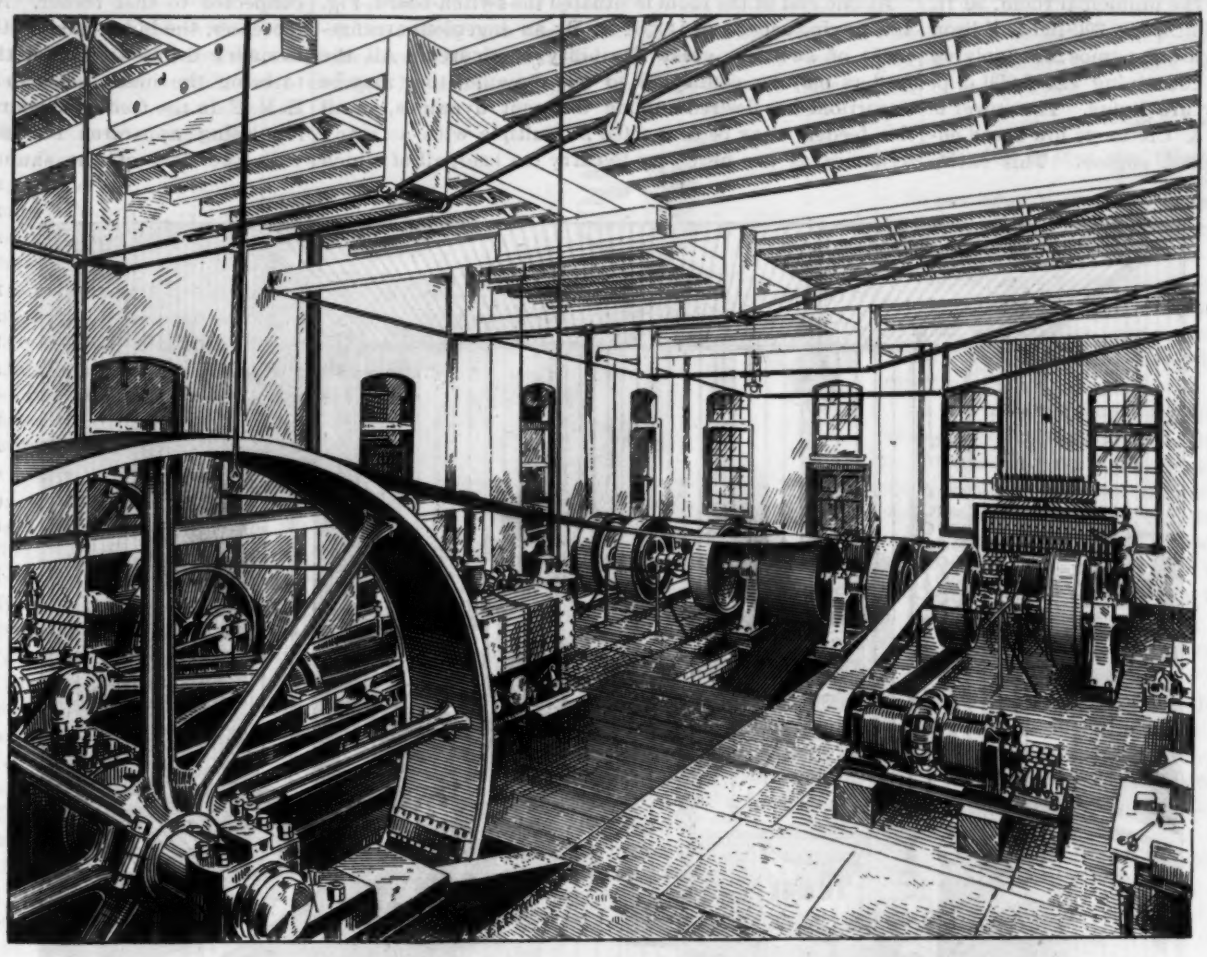


FIG. 1.—BRUSH ROOM, STATION OF THE COLORADO ELECTRIC COMPANY, DENVER, COL.

The station of the Colorado Electric Company consists of three departments; the Brush arc room, the municipal room and the Westinghouse room. The arc room, Fig. 1, covering 37 × 70 ft., contains seven 65-light Brush dynamos, supplying 450 arc lights of 2,000 c. p., driven by one 300 h.p. Wright engine, and one 50 h. p. high-speed engine. The switch-board is fitted with all the improved appliances for operating the different circuits and for protection in case of lightning. In this room has been begun the erection of a generating plant, which will be entirely independent of the other systems and have a capacity of 150 h. p. for running motors.

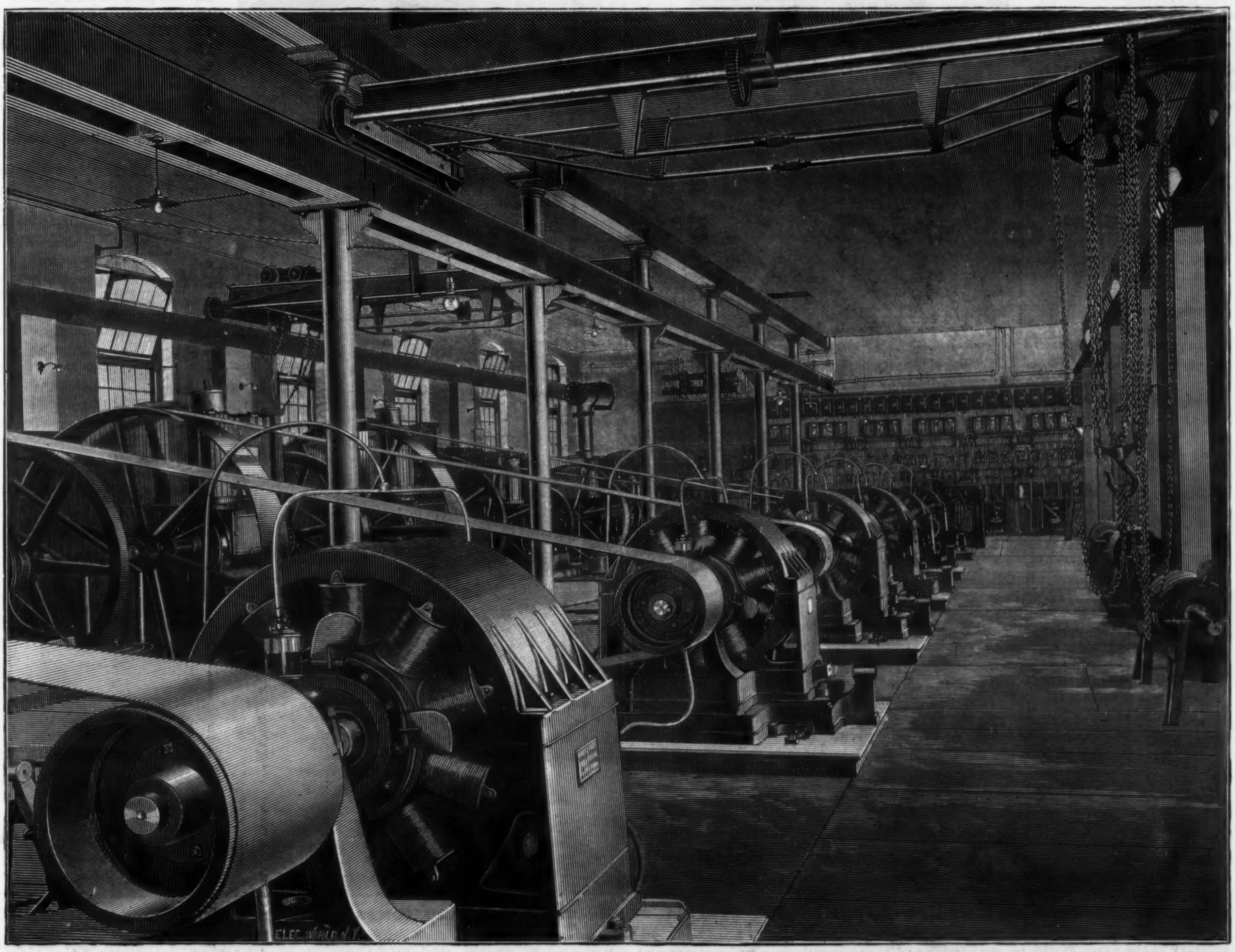


FIG. 2.—WESTINGHOUSE ROOM, STATION OF THE COLORADO ELECTRIC COMPANY.

Adjoining the arc room is the municipal room, 30 ft. wide by 61 ft. long, containing four 300-light Edison municipal dynamos and two Brush dynamos for supplying the seven iron towers, each containing six 3,000 c. p. Brush arc lights, and other city arc lights. The power is supplied by a 200 h. p. Fraser & Chalmers low-speed engine, and one 50 h. p. high-speed engine. This entire room, is used exclusively for supplying lights to the city, and is run on the moonlight schedule.

The boiler plant for the arc and municipal rooms consists of five 70 h. p. tubular boilers, and one 150 h. p. Heine boiler, with large coal bunkers for reserve coal. The few incandescent lights run on the arc circuits for commercial use gave the people a desire for a greater number and a more convenient means of using this desirable light, so last summer was begun the erection of an incandescent plant of the Westinghouse alternating system, adjoining the other large buildings of the company. The Westinghouse room, Fig. 2, 40 ft. by 100 ft., contains 4 1,300-light alternate current dynamos, each driven by a 150 h. p. Westinghouse automatic engine and two 650-light dynamos, each driven by a 75 h. p. Westinghouse engine, making a total capacity of 6,500 lights. Two 120-ampère 100-volt direct-current dynamos, each driven by a 25 h. p. Westinghouse engine, are used for exciting the fields of the alternate current machines. Either of these dynamos is ample for this purpose, the other being held in reserve. Two traveling cranes, one over the engines and the other over the dynamos, each capable of lifting entire any piece of machinery in the room, facilitates the handling of the apparatus when necessary, with the greatest of ease.

FIG. 3.—LABORATORY OF DENVER STATION.

Oil is supplied to the dynamos by a system of pipes, which carry the oil from an elevated tank; the oil after being used is carried in the same manner to another tank, where after being filtered, it is again forced into the distributing tank.

At one end of the room is situated the switch-board, Fig. 4, ocupying aspace of 11×34 ft. By an ingenious arrangement of switches, great flexibility is secured. All the feeders may be connected to one dynamo; they may be apportioned as desired among different dynamos, or all the feeders may be connected in multiple with as many dynamos as are necessary to carry the load, all of which methods are used as occasion demands. Each dynamo is supplied with an ampère-meter and each feeder with an ampère-meter and volt-meter. To obviate the necessity of a complex system of pressure wires from the centres of distribution to the station, small converters of special design are placed on the switch-board, the primaries of which are in series with one pole of the feeder and the secondary in series with, but giving an electromotive force in opposition to, the volt-meter connected to that feeder. As the current in the feeder increases, the index hand of the volt-meter is thrown back to such a degree that when the E. M. F. is raised enough to bring the index hand to the zero point, the drop of E. M. F. in the feeder is accurately compensated for. The regulating apparatus consists of a rheostat in series with the field of the shunt wound exciter, by which all the alternate current dynamos are regulated, and by separate rheostats in series with the field of each alternate current machine. No feeder equalizers are used, the drop on the feeders being in all cases less than 2 per cent.; but in actual practice, to obviate even this slight difference, heavily loaded feeders are run on one machine (or machines) and lightly loaded feeders on another. The steam for the Westinghouse plant is furnished by a battery of five 150 h.p. Heine boilers, and means are provided for connecting these boilers with those supplying the other departments of the station, in case of necessity. The boilers are fed from two artesian wells on the premises, sunk to a depth of 300 and 900 ft. respectively. This water is absolutely pure, and produces no scale in the boilers.

A railroad track at either side of the station facilitates the easy handling of coal, ashes and supplies.

The city of Denver is admirably planned for a system of electrical distribution, being laid out in rectangular blocks, with alleys midway between all streets, running east and west, thus enabling all converters to be attached to the rear of buildings. Through an underground conduit a feeder is run from the station, north and south through the main street of the city, to an alley where it is brought to the surface and connected to overhead mains running east and west through the alley. To the next alley a separate and distinct feeder is laid and connections are made with the mains. There are 18 of these feeders with their connecting mains, forming 18 separate and distinct circuits. A separate overhead feeder is

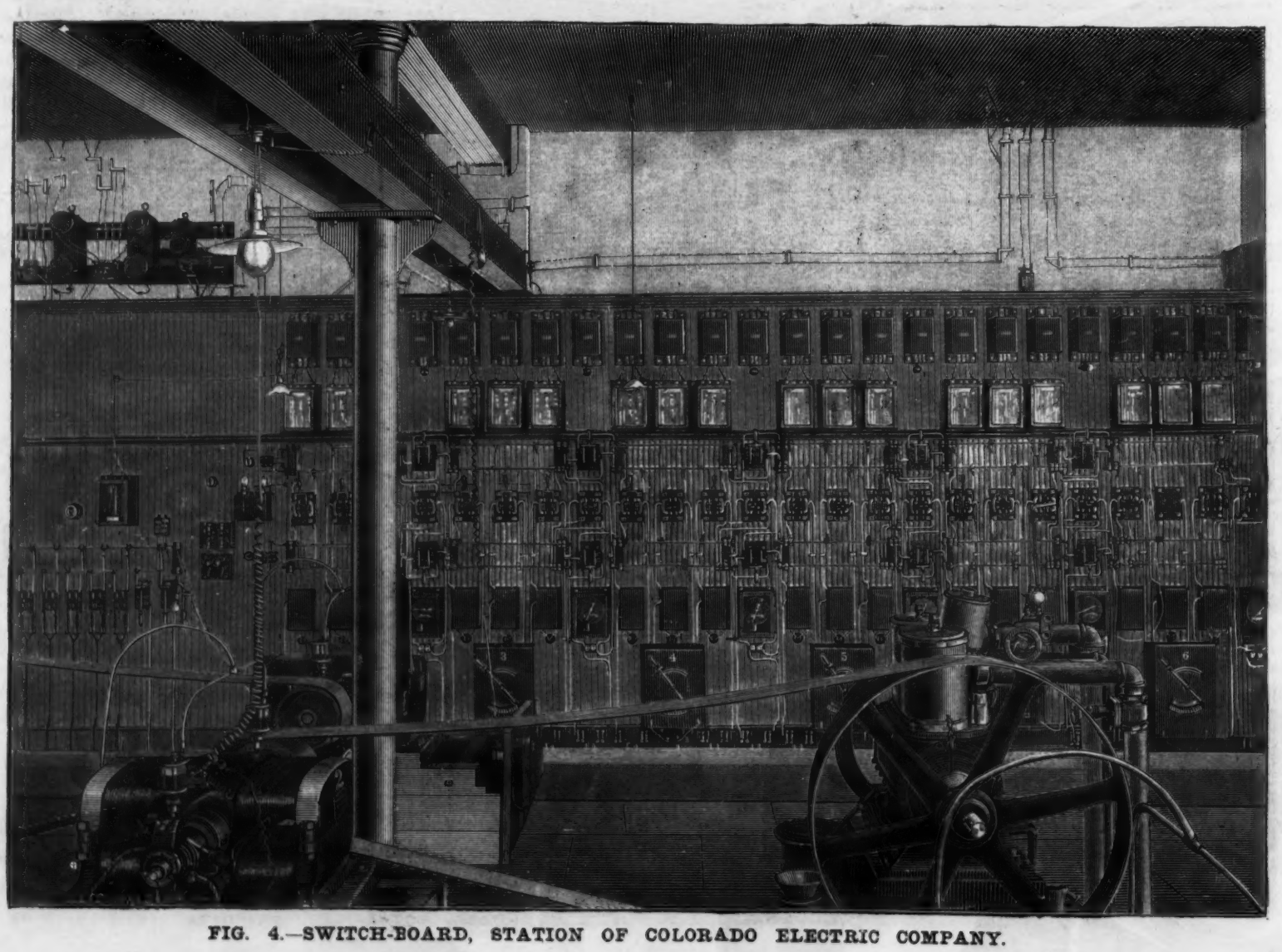


FIG. 4.—SWITCH-BOARD, STATION OF COLORADO ELECTRIC COMPANY.

run from the station past the ends of all mains, from which, in case of accident, any main or mains can be supplied by disconnecting it from the underground feeder and attaching it to this auxiliary main by switches, specially adapted to the purpose. Nearly 300 blocks of the city are now covered by the system, and the wires are being rapidly extended. The conduit used was manufactured by The Underground Electric Conduit Company, of Denver, and the cable by the Standard Underground Cable Company, of Pittsburgh, Pa. The latter is duplex lead-covered cable, varying in size from No. 4 to No. 0 B. & S. gauge. The shortest underground feeder is 3,090 feet long and the longest 8,000 feet. No loss from retardation or self-induction can be detected in these feeders, though the ohmic loss is in all cases less than 2 per cent. and additional loss would be readily detected. No secondary mains are in use, but primary service wires are run direct from the mains to the converters which are attached to the outside of the buildings.

The station runs night and day, and supplies nearly 7,000 incandescent lamps, with others being added as fast as they can be wired and connected by a large force of workmen. The demand for this light is so much larger than was anticipated that the present capacity will be entirely inadequate for the coming winter, and the company are making plans for an increase this fall.

The upper floor of the Westinghouse building contains the storeroom of the company, together with the repair shop and the electrician's laboratory. This laboratory any electric manufactory in the East might be proud of. To it are run all the wires from the different departments, thus affording to the electrician means of testing the circuits and placing at his command a wide range of currents for experimental and other purposes. There are wires carrying currents of from 3 to 120 ampères, with a range of E. M. F. of from 50 to 3,000 volts, of both continuous and alternating currents. The laboratory is equipped with a Bunsen photometer and all the latest improved testing instruments, such as ammeters, voltmeters, Wheatstone bridges, Thomson reflecting galvanometers, tachometers, etc., etc.: together with large banks of lamps for testing purposes. The officers of this company are: E. W. Rollins, president; N. M. Tabor, vice-president; F. C. Young, secretary and treasurer; A. H. Fowler, manager, and Richard H. Sterling, electrician.

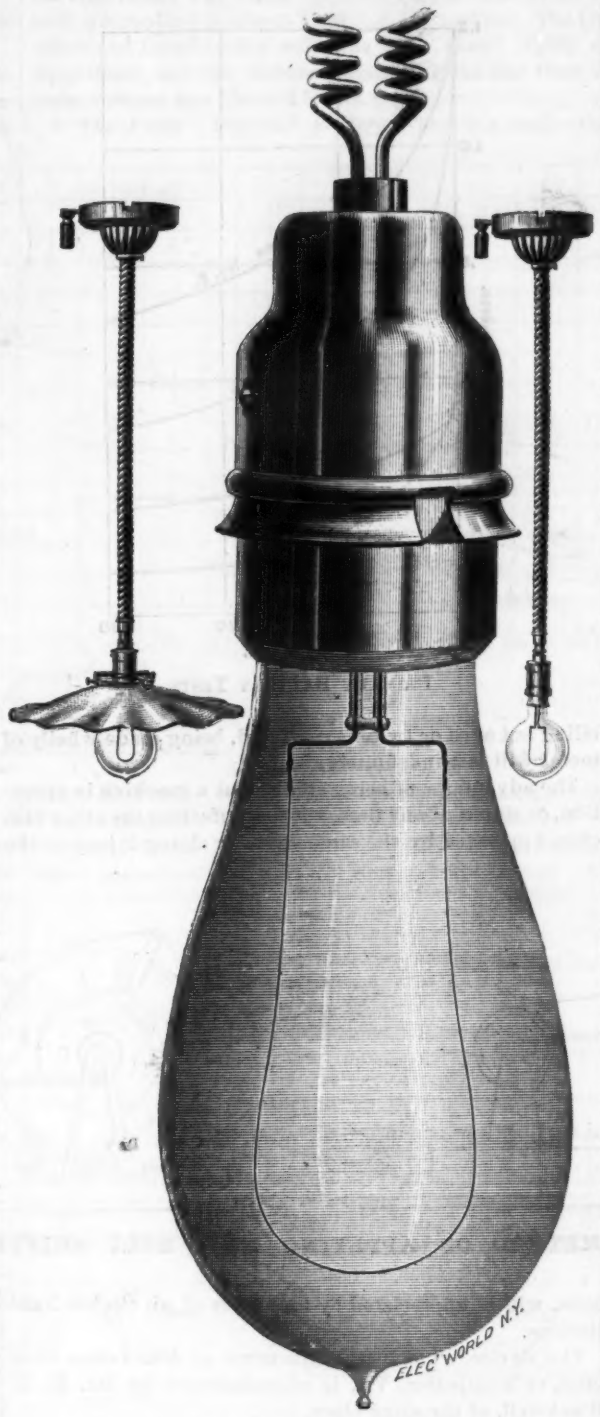
The Schaefer Incandescent Lamp.

We illustrate on this page the new lamps of the Schaefer Electric Manufacturing Company, of Boston. Fig. 1 is a cut of a 100 c. p., 100 volt lamp, about one-half size. This lamp is well adapted for large halls and places where much light is required, and besides furnishing the same amount of light as a number of smaller lamps, will give as good distribution and prove less expensive on account of saving in wiring and number of fixtures. These lamps are made to different voltages and have an efficiency of 2.7 watts per candle.

The holder or socket is constructed with the utmost simplicity, and the contact between lamp and holder is thoroughly reliable. The electrical connections are completed on inserting the lamps, which are perfectly insulated throughout, thus insuring to the person handling them no possibility of coming in contact with the current.

The increasing demand for low resistance lamps, to be used in series, on account of the advantages where distribution over large territory is desired, as well as their ready adaptation to use on arc light circuits, has induced this company to manufacture lamps with suitable devices for this purpose. Fig. 2 shows a combined fixture, complete, with a 100 c.p. lamp. The company also make lamps of 25 and 50 c. p. capacity, adapted to run on dynamos of all the ordinary ampèreages of current. These lamps have an efficiency of 2.5 to 2.8 watts per candle.

In the use of these lamps it is necessary to provide, in case of the failure of a lamp, that the circuit should not be broken and that there shall be no possibility of coming in contact in handling, with the high tension current used. Both of these features have been provided for. The socket and holder which carry the lamp are so constructed that if a lamp is removed by accident, or otherwise, it closes the circuit automatically, and thus does not disturb the circuit or invite damage from the current.



FIGS. 1, 2 AND 3.—THE NEW SCHAEFER LAMP.

The contacts and conducting parts are made heavy to allow free passage of the strong currents sometimes used. The holder also contains a paper cut-out, which, in case of breakage of lamp, closes the circuit, and which can be easily replaced by removing the shell.

The ceiling block, as seen in the cut, Fig. 3, also contains a paper cut-out under the brass rosette, and a switch for closing the circuit in case the lamp is not in use. The binding posts are concealed in wooden blocks diametrically opposite each other, thus again avoiding any possibility of coming in contact with them, the wires being held by a screw countersunk from the face of the block, so that it can be easily wired.

The Baxter Motor for Constant Potential Circuits.

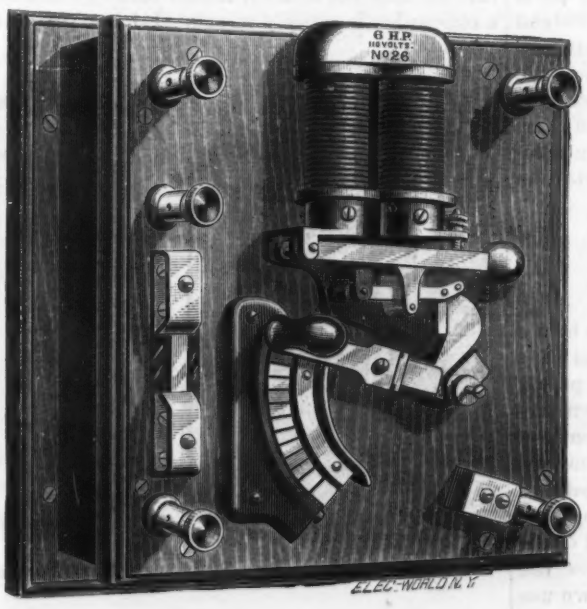
In our issue of Aug. 25 we gave an illustration and description of the newly designed Baxter constant current motor. This week we present to our readers an illustration of the new Baxter constant potential motor and the safety cut-out box devised by the inventor to prevent any liability of the armature burning out on starting, or under a heavier current load than the armature is designed to carry.

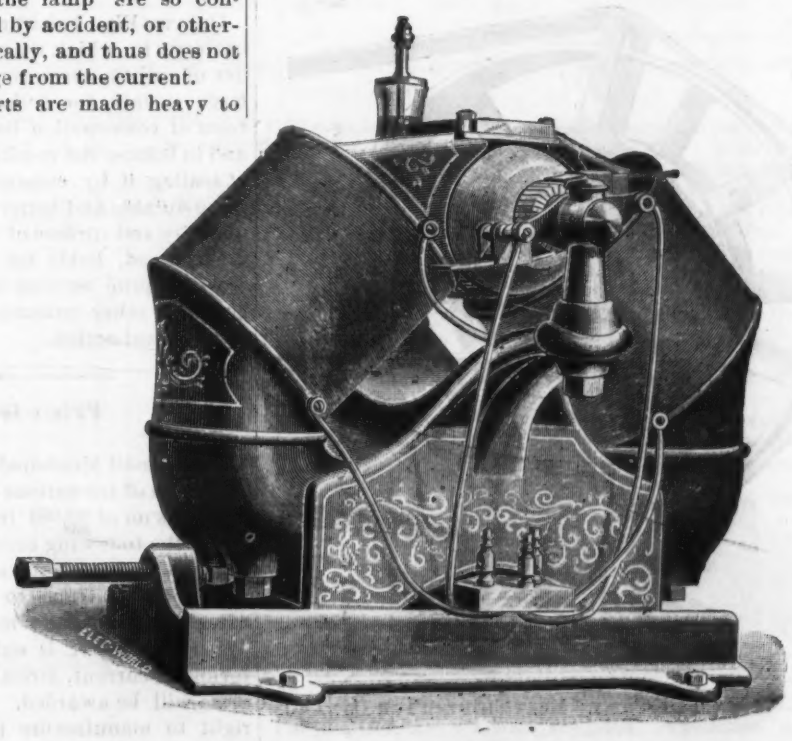
As will be noted from the engraving, Fig. 2, the appearance of the constant current and constant potential motors is identical, with the exception that the latter, being shunt wound, requires no mechanical speed governing device, as is the case with constant current motors. Indeed, for a given horse-power, the same frame of machine is used for motors of both types, the only difference being that the governor is omitted in the constant potential machines.

There is no switch attached to the base of the motor, as is the case with the constant current machines. In its stead there are three binding-posts with which the line wires leading from the cut-out box are connected. This box, which is illustrated in Fig. 1, performs within itself, by a simple movement of the single lever shown, all the operations effected by the two or more levers usually required.

In starting a constant potential motor, it is necessary to introduce a resistance into the armature circuit to prevent the heavy rush of current which would otherwise ensue on the closing of the circuit. This resistance is gradually removed as the motor acquires its normal speed and generates counter electromotive force. The field circuit must also be first established to create the field in which the armature is to revolve. Furthermore, provision must be made for an automatic and reliable arrangement by which the motor is cut out of circuit when the current becomes dangerously high for the safety of the armature. In the Baxter automatic cut-out box all of these conditions are rigidly fulfilled by the simple upward movement of the L lever shown in the illustration. Two brushes are carried by this swinging lever. When an attempt is made to start the motor, the inner and smaller brush situated nearest the pivot first makes contact with a brass strip and completes the field circuit. Immediately following, the outside brush comes in contact with the resistance blocks and the armature begins to revolve. While the armature is acquiring its normal speed, the upward movement of the lever is continued, gradually cutting out the resistance as the armature acquires speed, until the last block is reached and the lever becomes automatically locked in the position by the device shown.

The magnet above has its coils in the motor circuit, so that its influence upon the attracted armature to which the locking device is attached will vary according to the strength of current in circuit at any time. This magnet is so set as to trip the lever when the current increases to such an extent as to imperil the safety of the armature, either from an overload or other cause. The upward movement of the lever is opposed by a spring coiled round the pivot. Hence it is impossible to leave the brush in a position midway upon the resistance blocks, or to lock the lever when the current is already too high in starting; and the action of the cut out becomes instantaneous when the current rises to a strength higher than that for which





FIGS. 1 AND 2.—BAXTER MOTOR AND CUT-OUT FOR CONSTANT POTENTIAL CIRCUITS.

the trip magnet is set. As an additional precaution, a safety fusible strip is provided which blows out immediately after the tripping device fails to act.

By the use of this automatic cut-out box no injury can result to the motor from an excess of current at the time of starting or when under load; there is no confusion, as in the handling of two or more levers or connections, and its action is perfectly automatic, reliable and requires no attention. Each Baxter constant potential motor is accompanied by one of these automatic cut-out boxes. They are neat in appearance, compact, taking up a wall space of only 13 by 13 inches, and permit of easy and rapid adjustment when required.

The Practical Belt Shifter.

The accompanying illustrations show a new device for the safe and rapid handling of swift running belts, such as those employed for running dynamos, without the use of the wasteful loose pulley. The engraving, Fig. 1, shows the belt shifter in perspective, and Figs. 2 and 3 show two different methods of connecting it with the dynamo pulley.

As will be seen, there is placed beside the driving pulley a double armed spider, having spokes *E*, *F*, *G*, and supported by standards, which also form the support for the shaft bearings.

The oppositely located arms are connected at their extremities by means of rods, which carry rollers extending across the face of the driving pulley at a short distance therefrom. The spider is rotated about its axis by means of a horizontal worm-shaft *I*, on one end of which is a hand-wheel *i*. the other end meshing with a gear secured to the outer disc *D*. The operator by turning the hand-wheel rotates the discs and carries the radial arms from a position where they are between the upper and lower parts of the belt, facing the dynamo, and out of contact with the belt, to a position where they rest beneath and in contact with the belt, as shown, and thus raise the latter from the driving pulley, so that the same may revolve without touching the belt. The illustrations show the belt off the driving pulley, and also show one of the radial arms movable, which allows the arm to fold up against the next arm, so as to occupy less space between the upper and lower portion of the belt, when they cease to raise the belt from the pulley and pass to a state of rest.

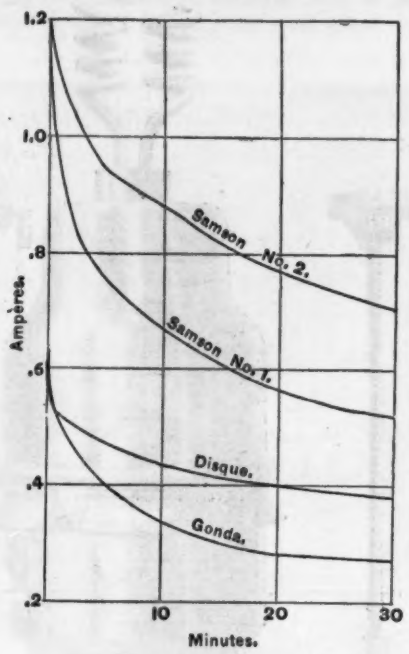
FIG. 1.—THE "PRACTICAL" BELT SHIFTER FOR DYNAMOS.

In order to lift the belt from the driving pulley it is necessary to slacken the belt, so that the roller on the arms of the spider may pass between the belt and the driving pulley. Where the machine to be driven can be placed on a sliding brace, Fig. 2, such as dynamos are usually mounted on, the machine is moved forward and back and the belt lifted off and on by the same hand-wheel. Where the machine cannot be moved the tightening device shown in Fig. 3 is used. There is no skill required to set up or operate the shifter, and the belt is always kept in the same position, without side movement or tendency to wear or strain the belt in any manner.

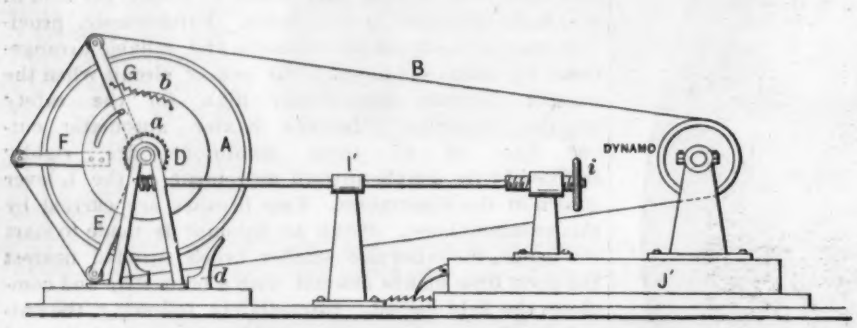
There is no bearing on the shaft, consequently there is no friction or consumption of power. The shifter requires oiling but once or twice a year, and, being made wholly of metal will last indefinitely.

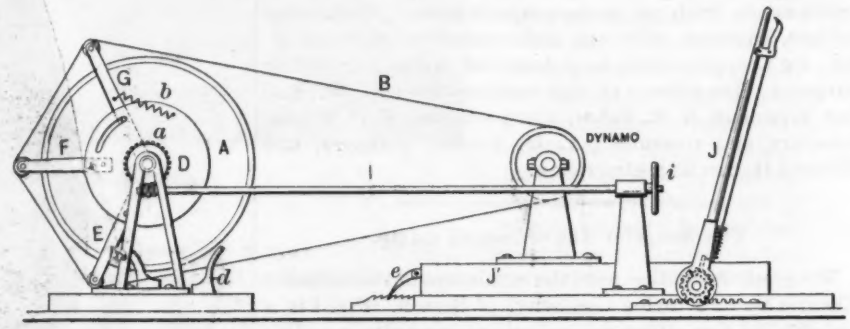
The advantage of being able to put a machine in operation, or stop it at any time, without affecting the other machines operated by the same shaft, or doing injury to the belts, will be appreciated by managers of all electric light stations.

The device, which is the invention of Mr. James Canning, of Montpelier, Vt., is manufactured by Mr. E. D. Blackwell, of the same place.



PRIMARY BATTERY TESTS.





FIGS. 2 AND 3.—METHOD OF APPLYING NEW BELT SHIFTER TO DYNAMOS.

The New Law Battery.

Our cuts Figs. 1 and 2 represent the latest form of the Law battery, in which the negative element is a double cylinder of carbon, one within the other, and thus exposing a large surface for action. The advantages of the new form of construction lie in the fewer number of parts and in bolting the negative element to the cover instead of sealing it by cement as heretofore, thereby getting a more durable and better fastening. Because of the large quantity and surface of the negative element, the battery, it is claimed, holds up under hard work or when overworked quite as long as those batteries containing manganese or other substances to accomplish depolarization by chemical action.

Prizes for Electric Meters.

The Conseil Municipal of Paris have decided to hold a collection of the various kinds of electric meters, and have voted a sum of 20,000 francs to be distributed as prizes, under the following conditions: 10,000 francs to the inventor who produces a meter giving entire satisfaction; five prizes of 2,000 francs to the five inventors whose meters, after this, show the most important progress realized. Where the meter is only applicable to one of the two forms of current, direct and alternating, only half of the prize will be awarded. The city of Paris reserves the right to manufacture the prize meters for its own use without further payment.

Primary Battery Tests.

To the Editor of the Electrical World:

SIR: The strictures of B. J. W. in your journal of July 14th, upon my report upon some primary batteries which I examined some time ago, seem to require some notice from me. Sickness and pressure of other work have prevented me from answering sooner.

That B. J. W. and others interested in such batteries may have more complete data for a judgment, I have put into graphic curves the observations made upon all four of the cells tested, making ampères ordinates and time in minutes abscissas, and from these a simple inspection will serve to show where superiority lies.

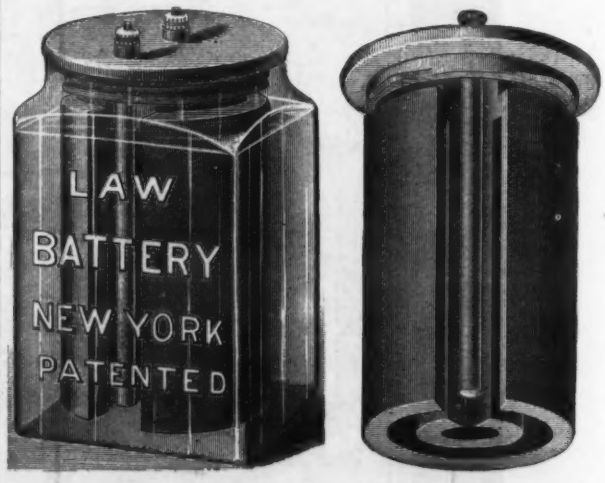
It may be well to say that the electromotive force of each cell was measured on open circuit by the condenser method and upon the assumption that Clark's standard cell gives 1.45 volts. The current was measured upon a standardized galvanometer, having a known constant, and the current was computed. It appears there was a clerical error in which cell No. 2 was credited with 1.11 ampères when it should have been 1.21 ampères, as the record shows.

Taking either figures I am at a loss to understand the mental process by which B. J. W. concludes that there is no "marked superiority" of the "Samson" over the Leclanché. During the whole time of the trial both Samsons gave a much stronger current than either of the others. Neither do the indications at the end of the half hour warrant the conclusion that if the trial had continued for an hour the superiority of the Samson would have been less apparent, for the curves are running nearly parallel, as one may see.

But I must object to such a trial as being entirely inappropriate with any such kinds of batteries. By such a test a gravity cell would prove superior to a Grove or a bichromate cell. Each has its proper field of work and is best for it. What is wanted of an open circuit battery is that it shall give the strongest possible current during the short interval it is in use, with ability to recover quickly after use. For such work as ammonium chloride cells are adapted to, ringing bells, lighting gas, working telephone transmitters, etc., a strong current is needed for a brief time and a continual service of as much as five minutes is very unusual. A test continued for more than five minutes is not so much a test of the proper quality of such a cell as it is of the quality of constancy, and no one expects constancy of an ammonium chloride cell. The problem is to get the most out of one for half a minute or so, and I submit that the showing of the Samson cells is much superior to the others with which they were compared.

One thing more about primary batteries, to which so much attention is now being given by experimenters and theorists. The latter seem to have come to the conclusion that nothing much better than what we already have is to be looked for. The extensive series of observations on electromotive force of various chemical combinations lately published seemed to lead to the conclusion that from carbon, zinc and common cheap chemicals we may not look for higher battery efficiency. Such a conclusion is entirely wrong. I have this summer examined a battery made up of carbon, zinc and very familiar chemicals that has an electromotive force of 2.87 volts. The English *Electrical Review* does not believe it, nevertheless it is true. I wish that those who draw negative conclusions about scientific matters would limit such conclusions to their actual data, and I would encourage those who are hoping for better work from primary batteries to continue their experiments, for a strong, constant primary battery has a great field of usefulness. Improvements are constantly being made, and there is good reason to hope for a cell superior to any yet made.

COLLEGE HILL, Mass. A. E. DOLBEAR.



FIGS. 1 AND 2.—THE IMPROVED LAW BATTERY.

Tests of Primary Batteries.

BY A. E. KENNELLY.

The following are the results of trials made at Mr. T. A. Edison's laboratory of three forms of primary battery:

DESCRIPTION OF CELLS FOR CONTINUOUS WORK AS SUPPLIED TO THE LABORATORY.

1. *The Roberts-Brevoort Battery.*—This was a zinc-carbon two-fluid cell. The outer jar was of wood, rectangular and metal-lined on the inside, the interior dimensions being 22.5 × 20 × 38 cms. deep (15 in. × 7⅞ in. × 15 in. deep). It contained three carbon plates, each 40 × 17.3 × 0.5 cms. (15¾ in. × 6¾ in. × ⅛ in.), weighing about 900 grams (2 lbs.), and exposing about 1,700 sq. cms. (264 sq. in.) of active area in solution, exclusive of the two extreme faces.

Between these three carbon plates were two of zinc, each in a separate jar of porous stoneware. These zinc plates weighed about 1,815 grams (4 lbs.), were about 35.6 × 15.3 × 0.4 cms. (14 in. × 6 in. × 5/32 in.), and their total surface of 2,150 sq. cms. (333 sq. in.) exposed jointly about 1,850 sq. cms. (287 sq. in.) actively in solution. They were apparently unamalgamated.

The porous jars were rectangular, with rounded corners, the interior dimensions being 16.7 × 4 × 35.5 cms. deep (6½ in. × 1⅝ in. × 14 in. deep), and their thickness was about 0.4 cms. (¼ in.).

The solution in the porous jars round the zinc was of common salt, very dilute, about 2,000 c.c. (2 quarts). That in the outer cell being of a special nature, about 6,000 c.c. in amount (1½ gallons), and having the appearance of a preparation from bichromate of potash. The intervening distance between the plates constituting opposite poles was about 2.5 cms. (1 in.), and the total quantity of liquid in the cell amounted to about 10,000 c.c. (2½ gallons).

2. *The Mason-Wood Battery* was also a zinc-carbon two-fluid cell. The outer jar was of stoneware expanding upwards, the mean internal dimensions being 25 × 18 × 31 cms. deep (9⅞ in. × 7 × 12¼ in. deep).

It contained two carbon plates metallically connected at their upper edges, and 2.5 cms. (1 in.) apart, their dimensions being 32 × 15 × 0.5 cms. (12½ in. × 5¾ × 1/6 in.), and exposing jointly about 750 sq. cms. (116 sq. in.) of surface on the outside faces in solution. They rested in a rectangular jar of porous stoneware occupying the centre of the cell. The interior dimensions of the porous jar were 16.5 × 5.5 × 17.5 cms. deep (6½ in. × 2⅛ in. × 10⅜ in. deep), and the thickness about 0.6 cm. (3/16 in.).

The zinc plates were two in number, supported one on each side of the porous cell. Their dimensions were 33 × 15.4 × 0.5 cms. (13 in. × 6 in. × ⅛ in.), the weight being about 2,300 grams (5 lbs.), and they exposed jointly about 1,200 sq. cms. (185 sq. in.) of active surface in solution. They were amalgamated.

The solution in the porous cell round the carbon plates was of a special nature, having the appearance of a preparation from bichromate of potash, and about 1,250 c.c. (⅓ gallon) in volume. That in the outer jar round the zinc plates was water containing 5 per cent. sulphuric acid, amounting to about 9,000 c.c. (2⅓ gallons). The total volume of liquid in the cell was thus about 10,250 c.c. (2⅔ gallons), and the distance separating the zinc from the carbon plates was about 3.5 cms. (1½ in.)

3. *The Fitch "Perfect" Battery.*—This is a zinc-carbon single-fluid cell. It was submitted for trial in two forms:

(*a*) In the first form the outer jar was of glass and rectangular, closed by a circular stoneware stopper, through which passed a single zinc rod and a single carbon plate. The interior dimensions were 9.5 × 9.5 × 14 cms. deep (3¾ in. × 3¾ in. × 5½ in. deep).

The zinc rod was 17 cms. (6¾ in.) long and 1 cm. (⅜ in.) diam., weighing about 63 grams (2¼ oz.). The carbon plate, triangular in form, 17 × 5 (mean) × 0.7 cms. (6¾ in. × 2 in. [mean] × 7/16 in.), weighed about 90 grams (3⅛ oz.). The distance between the zinc and carbon was about 2.5 cms. (1 in.). The jar was filled to a height of about 10 cms. (4 in.) with water, a volume of about 1,000 c.c. (1 quart) containing in solution 150 grams (5¼ oz.) of a special excitant in the form of white powder.

(*b*) In the second form, not supplied, but set up according to directions, the outer cell was of glass and rectangular, the internal dimensions being 23 × 15 × 20 cms. deep (9 in. × 6 in. × 7⅞ in. deep), held 7 plates, 4 of carbon and 3 of zinc, in alternate order, separated by wooden strips and rigidly clamped. The carbons were supplied for the purpose. They were each 23 × 15 × 1.3 cms. (9 in. × 6 in. × ½ in.), and weighed 730 grams. (1 lb. 12 oz.). The zincs were each 19 × 16 × 0.6 cms. (7½ in. × 6¼ in. × ¼ in.), and weighed about 1,470 grams (3¼ lbs.). They were amalgamated. The active surface of zinc in solution was about 1,350 sq. cms. (210 sq. in.). The separating distance between the plates was 0.8 cm. (5/16 in.). The solution was about 3,800 c. c. (1 gallon), and rose to a height of 17 cms. (6¾ in.) in the cell, and contained about 1,200 grams (3 lbs. 6 oz.) of the excitant.

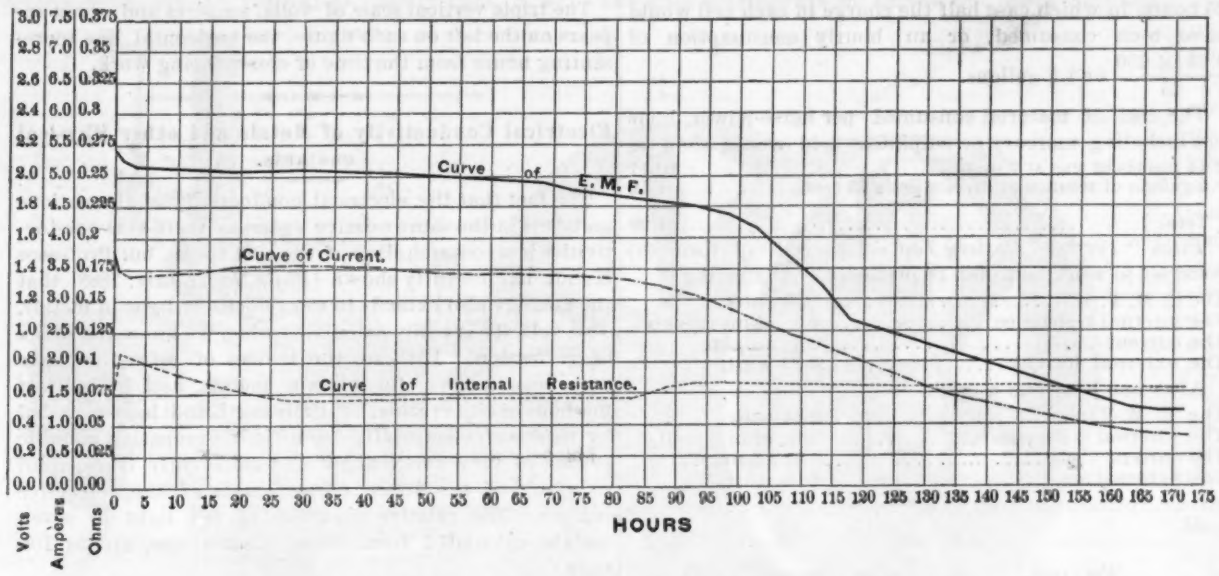


FIG. 1.—CURVES OF ROBERTS-BREVOORT BATTERY.

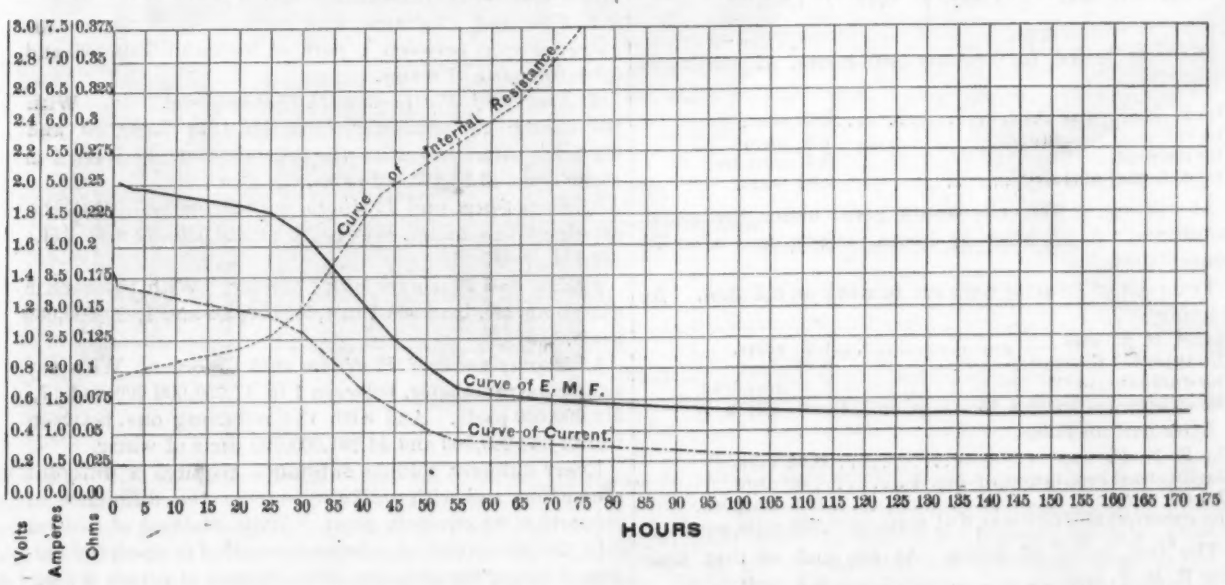


FIG. 2.—CURVES OF MASON-WOOD BATTERY.

METHOD OF TESTING.

The method employed was the same for all the cells. A set of resistances of 0.5 legal ohm was made of stranded platinoid wire, and the cells were set to work continuously through this resistance. The potential difference at the cell terminals was observed every few hours with a potentiometer, both while the wire was in circuit and while disconnected for a few seconds in order to observe electromotive force. From these observations the E. M. F., current and internal resistance of each cell were calculated. These observations were plotted on curves, and from the curves the activity of each cell was calculated.

Roberts-Brevoort Test.—Three cells were set to work separately and simultaneously on the morning of June 15, on 0.5 ohm platinoid strand. They were not interfered with in any way beyond keeping the water up to level in the porous cells by addition, according to instructions.

The E. M. F. commenced at..... ....2.1 volts.
The internal resistance.....0.06 ohm.
The current.....3.8 ampères.
The activity externally.....7.2 watts.

The test lasted for 165 hours. At the end of this period the
E. M. F. was..... .....0.45 volt.
Internal resistance.....0.08 ohm.
Current.....0.8 ampère.
External activity..... ....0.32 watt.

TABLE I.

Cell Number.	Quantity delivered. Coulombs.	Energy developed. Externally. Joules.	Energy developed. Internally. Joules.	Energy developed. Total. Joules.	Per cent. of energy developed externally.	Zinc consumed. Theoretical consumption. Grams.	Zinc consumed. Actual consumption. Grams.	Zinc consumed. Waste. Grams.	Zinc consumed. Per cent. of consumption wasted.
No. 1.....	1,538,000	2,512,000	178.000	2,690.000	93.4	518	1,303	785	60.24
No. 2.....	1,315 000	1,772,000	294,000	2,066.000	85 8	443	516	73	14 2
No. 3	1,303,000	1,798,000	293,000	2,091,000	86.0	439	516	77	14.9
Mean.....	1,385,000	2,027,000	255,000	2,282,000	....	....	....	....	....

TABLE II.

Cells.	Quantity delivered. Coulombs.	Energy developed. Externally. Joules.	Energy developed. Internally. Joules.	Energy developed. Total. Joules.	Per cent of useful energy developed	Zinc consumed. Theoretical. Grams.	Zinc consumed. Actual. Grams.	Zinc consumed. Waste. Grams.	Zinc consumed. Per cent. of waste.
No. 1.....	1,6 6,000	2,518,000	375.600	2,894,000	87	557.5	607	49.5	8.16
No. 3.....	1,637,500	2,465,000	400,000	2,865,000	86	551	622	71	11.4
Mean.....	1,647,000	2,492,000	388,000	2,880,000	86.5	.....	.....	.....	9.8

The energy developed by the cells was as follows. (See Table I.):

The mean delivery of useful energy during the 165 hours was thus 2,027,000 joules, or ..... 1,494,000 foot-pounds.
The maximum delivery was 2,512,000 joules, or.....1,852,000 foot-pounds.
The minimum delivery was 1,772.000 joules, or.....1,306,000 foot-pounds.
The rate of doing useful work was, for the first five hours, 8.3 watts for cell No. 1 = 0.011 h. p., or.....90 cells per h. p.
First five hours, 6.15 watts for cell No. 2 = 0.008 h. p., or.....121 cells per h. p.
First five hours, 6 35 watts for cell No. 3 = 0.0085 h. p., or.....117.5 cells per h. p.
The lifetime of the cells at full power as observed from the curve was about 75 hours, at 3.5-ampères mean = 262 ampère hours, at 3.5 ampères.

Extended over the whole period of the test the figures are:

Cell No. 1, mean current, 2.59 ampères = 427 ampère hours, at..... 2.59 ampères.
Cell No. 2, mean current, 2.21 ampères = 365 ampère hours, at..... 2.21 ampères.
Cell No. 3, mean current, 2.19 ampères = 362 ampère hours, at.....2.19 ampères.

The cells were taken down on June 22, at the conclusion of the test, and the zincs weighed. The losses are stated above. They were then set up again on July 9, the zincs amalgamated and weighed afresh. For want of solution only two of the cells were run on 0.5 ohm as before. The test lasted for 170 hours.

The results were as follows. (See Table II.):

The mean delivery of useful energy during the 170 hours was thus.....2,492,000 joules.

The rate of doing useful work was, for the
First five hours, 6.12 watts for cell No. 1, or 0.008 h. p., or.....123 cells per h. p.
First five hours, 5.78 watts for cell No. 2, or 0.0078 h. p., or.....129 cells per h. p.

The mean current for the whole period was:

No. 1. 2.71 ampères = mean capacity of 460 ampère hours at .....2.71 ampères.

No. 2. 2.68 ampères = mean capacity of 460 ampère hours at .....2.68 ampères.

The improved performance of these cells on their second trial was supposed to be due to the amalgamation of the zincs.

Although about 120 cells at starting develop usefully one horse-power, for steady continuous working 150 would probably, judging from the curve, be necessary. The duration of the cells would be practically, say, 120 hours, and this would mean $\frac{150 \times 1.5}{120}$, or 1.9 gallons of solution per horse-power hour. Also, since 370 ampère hours per cell consume one pound of zinc, and allowing 10 per cent. for waste, this would mean a consumption of $\frac{3.5 \times 150 \times 1.1}{370}$, or 1.56 pounds per horse-power hour.

The cost of material consumed per horse-power hour, excluding common salt and mercury, is, at the invoice prices:

1.9 gallons of solution at 20 cents	$0.38
1.56 pounds of zinc at 7 cents	0.11
Total	$0.49

Mason-Wood Test.—Three of these cells were set up on July 8 and set to work under the same conditions as those above described for the Roberts-Brevoort cell, *i. e.*, each through 0.5 ohm. It should be stated that cell No. 1 had a double head on its carbon, necessitated through fracture of plates, and that through an oversight this was found to be in contact with the zincs two hours after setting up the battery, and before it commenced work. The extra waste and diminished output of this cell render it probable that short circuiting took place during that time and consequently the statements and deductions which follow are based on the other cells, Nos. 2 and 3:

The E. M. F. at starting was.....2.09 volts.
The internal resistance.....0.07 ohm
The current.....3.7 ampères.
The external activity.....6.8 watts.

The test lasted 170 hours. At the end of that time

The E. M. F. was.....0.5 volt.
The internal resistance.....0.5 ohm.
The current.....0.5 ampère.
The external activity.....0.13 watt.

The plates were then weighed and the results found to be as follows. (See Table III.):

The mean delivery of useful energy during the 170 hours was thus 718,000 joules.

The rate of doing useful work was for the first 5 hours, for cell No. 2, 5.8 watts.....or 129 cells per h. p.

First 5 hours, for cell No. 3, 5.4 watts, or 138 cells per h. p.

After 25 hours, for both cells, 4.4 watts, or 168 cells per h. p.

After 50 hours, for cell No. 2, 0.7 watt, or over 1,000 cells per h. p.

After 50 hours, for cell No. 3, 0.6 watt, or over 1,000 cells per h. p.

The mean current during the whole test was 1.24 ampères for No. 2, a mean capacity of 210 ampère hours, and 1.20 ampères for No. 3, a mean capacity of 204 ampère hours.

Consequently from these results, to supply 1 h. p. for 25 hours would require, say, 150 cells. The mean current during that time would be 3.25 ampères and the zinc consumed per hour, allowing 370 ampère hours per pound and 50 per cent. waste, would be $\frac{3.25 \times 150 \times 2}{370}$ or 2.44 pounds.

The solution would be, say, half exhausted at the end of 25 hours, in which case half the charge in each cell would have been consumed, or an hourly consumption of $\frac{0.25 \times 150}{25}$ or 1.5 gallons.

The cost of material consumed per horse-power hour not including mercury or sulphuric acid would then be

2.44 pounds of zinc at 7 cents	$0.17
1.5 gallons of solution at invoice price 75 cents	1.12
Total	$1.29

Fitch "Perfect" Battery Test.—Two cells of form (*a*) were set to work on 1 ohm of platinoid. At starting

The E. M. F. was.....1.33 volts.
The internal resistance.....2.0 ohms (nearly).
The current.....0.5 ampère.
The external activity.....0.25 watt.

After one hour and a half

The E. M. F. was.....0.44 volt.
The internal resistance.....1.0 ohm (about).
The current.....0.25 ampère.
The external activity.....0.06 watt.

TABLE III.

Cell.	Quantity delivered in 170 hr's. Coulombs.	Energy developed. Externally. Joules.	Energy developed. Internally. Joules.	Energy developed. Total. Joules.	Per cent. of total energy externally developed.	Zinc consumed. Theoretically. Grams.	Zinc consumed. Actually. Grams.	Zinc consumed. Waste. Grams.	Zinc consumed. Per cent. lost in waste.
No. 1	604,400	495,300	181,200	676,500	73.2	203.5	546	342.5	62 7
No. 2	734,800	730,000	202.500	932,500	78.3	247.4	524	276.6	52.8
No. 3	711,000	705,700	257,700	963,400	73.3	239.4	521	281.6	54.1
Mean of 2 and 3	723,000	718,000	230,000	948,000	75.8	.....	.....	.....	53.5

TABLE. IV.

Cell.	Quantity delivered in 95 h'rs Coulombs.	Energy developed. Externally. Joules.	Energy developed. Internally. Joules.	Energy developed. Total.	Per cent. of energy usefully developed	Zinc consumed. Theoretically. Ounces.	Zinc consumed. Actually.	Zinc consumed. Waste.	Zinc consumed. Per cent. of zinc wasted.
No. 1	312,000	143,240	17,050	160,300	89.4	3.74	4.5	0.76	16.9
No. 2	282,000	117,180	36,940	154,120	76.0	3.39	4.75	1.36	28.6
Mean	297,000	130,200	27,000	157,200	82.7	.....	.....	.....	22.8

TABLE V.

Cell.	Quantity delivered in 170 hours. Coulombs.	Energy developed in 170 hours. Total. Joules.	Energy developed in 170 hours. Available. Joules.	Per cent. of energy available.	Foot-tons of useful energy developed in 170 hours.	Rate of supply for first 5 hours. Watts.	Cells per h. p. after first 5 hours.	Rate of supply after 24 hours. Watts.	Cells per h. p. after 24 hours.	Cost of material for 1 h. p. hour for 25 hr's.
Roberts-Brevoort	1,647,000	2,880,000	2,492,000	86.5	820	5.95	125	6.4	117	$0.49
Mason-Wood	723,000	948,000	718,000	75.8	236	5 6	133	4 4	168	1.29
Same particulars for Fitch battery, form (*b*), 95 hours only.										
Fitch "Perfect"..	297,000	157,200	130,200	82.7	43	0.41	1,820	0.40	1,865	....

The test lasted for seventy-two hours, at the end of which time

The E. M. F. was.....0.2 volt.
The internal resistance.....1.5 ohms.
The current.....0.1 ampère.
The external activity.....0.01 watt.

At starting, 2 600 cells would give, under the above conditions, 1 h. p.: after 1½ hours, 12,400; and after 72 hours, 75,000.

Two cells of form (*b*) were set to work on 0.5 ohm. At starting

The E. M. F. was.....1 2 volts.
The internal resistance.....0.19 ohm.
The current.....1.7 ampères.
The external activity 1.45 watts, or 514 cells per h. p.

After half an hour

The E. M. F. was.....0.65 volt.
The internal resistance of No. 1.....0.09 ohm.
The current.....0.9 ampère.
The external activity was 0.41 watt, or 1,820 cells per h. p.

The test lasted 95 hours. At the end of that time

The E. M. F. was.....0.5 volt.
The internal resistance was.....0.06 ohm.
The current was.....0.85 ampère.

The external activity was 0.36 watt or 2,070 cells per h. p.

The results are as follows: (See table IV.)

To supply one horse-power for 25 hours about 1,300 cells would be required.

The comparison, therefore, stands as follows: (See table V.)

It was found impossible to present all the 36 curves of observation that are derived from the above 12 trials in a convenient, condensed form for publication. An attempt, however, has been made to supply the deficiency in data which their absence would undoubtedly entail by showing in Figs. 1 and 2 the mean curve of the Roberts-Brevoort and Mason-Wood trials. Fig. 1 shows the mean E. M. F., internal resistance and current obtained from plotting the mean observations of the Roberts-Brevoort cells Nos. 1 and 3 on their second trial, which led to the results of Table II. Fig. 2 shows the similar curves from the mean observations of the Mason-Wood cells Nos. 2 and 3, referred to in Table III.

The triple vertical scale of volts, ampères and ohms appears on the left on each figure, the horizontal line representing hours from the time of commencing work.

Electrical Conductivity of Metals and other Physical Constants.

The fact that the electrical conductivity of the various metals is in the same relative order as their heat conductivities is a commonplace of the text books, but Professor Kundt has recently shown (*Phil. Mag.*, July, 1888) that the analogy also extends to the velocity of light in metals. This velocity is easily calculated when we know the index of refraction. Hitherto the indices of refraction have only been known for certain metals, and by indirect methods of observation, but Professor Kundt has succeeded by means of electrolytic deposition in preparing metallic prisms of very small angle and sufficiently transparent to admit of the direct measurement of the refractive indices. The relative velocities of red light in seven metals, calculated from these observations, are as follows:

Silver	100	Iron	14.9
Gold	71	Nickel	12.4
Copper (impure)	60	Bismuth (crystallized)	10.3
Platinum	15.3		

The order will be seen to be the same as that of relative electrical conductivities. The number 60 for copper appears to be too small, but Professor Kundt thinks that this is probably due to the existence of traces of cuprous oxide in the prism. He is now engaged in investigating the influence of a magnetic field upon the velocity in question.

The "Voltaic Balance."

BY DR. G. GORE, F. R. S.

A new and simple lecture experiment. Take two small clean glass cups containing distilled water, simultaneously immerse in each a small voltaic couple composed of either unamalgamated magnesium, or zinc with platinum, taking care that the two pieces of each metal are cut from the same piece and are perfectly clean and alike. Oppose the currents of the two couples to each other through a sufficiently sensitive galvanometer, so that they balance each other and the needle does not move. Now dip the end of a slender glass rod into a very weak aqueous solution of chlorine, bromine, iodine, or hydrochloric acid, and then into the water of one of the cups. The voltaic balance is at once upset, as indicated by the movement of the needle, and may be shown to a large audience by means of the usual contrivances.

The chief circumstance to be noticed is the extraordinarily great degree of sensitiveness of the arrangement in certain cases. This is shown by the following instances of the minimum proportions of substance required to upset the balance, with an ordinary astatic galvanometer of 100 ohms resistance, and with a Thomson's reflecting one of 3,040 ohms resistance.

1. *Zinc and Platinum with Iodine.* With the astatic galvanometer, between 1 part of iodine in 3,100,000 and 3,520,970 parts of water.

2. *Zinc and Platinum with Hydrochloric Acid.* With the astatic galvanometer, between 1 in 9,300,000 and 9,388,185 parts; and with the reflecting one, between 1 in 15,500,000 and 23,250,000 parts.

3. *Magnesium and Platinum with Bromine.* With the astatic galvanometer, between 1 in 310,000,000 and 344,444,444 parts.

4. *Zinc and Platinum with Chlorine.* With the astatic galvanometer, between 1 in 1,264,000,000 and 1,300,000,000 parts.

5. *Magnesium and Platinum with Chlorine.* With the astatic galvanometer, between 1 in 17,000,000,000 and 17,612,000,000 parts. And with the reflecting one, between 1 in 27,062,000,000 and 32,291,000,000 parts of water.

Every different soluble substance requires a different proportion, and with unlike substances the difference of proportion is extremely great. With solutions of neutral salts the proportion of substance required to upset the balance is large; for instance, with chlorate of potash a zinc-platinum couple and the astatic galvanometer, it lay between one part in 221 and 258 parts of water.

The degree of sensitiveness of the balance is usually greater the greater the degree of chemical affinity the dissolved substance has for the positive metal and the less it has for the negative one.

By first bringing the balance with a magnesium-platinum couple and the astatic galvanometer nearly to the upsetting point by adding one part of chlorine to 17.612 million parts of water and then increasing the proportion to one in 17,000 millions, the influence of the difference, or of one part in 500,000 millions, was distinctly detected.

The "Dick & Church" Automatic Engine.

The increasing demand for high speed engines for electric lighting and other purposes has led to the design of the above engine, which commends itself especially to the attention of electricians and those requiring high speed engines, owing to many points in design and construction peculiarly adapting it for driving dynamos. There are now over twenty of these engines in successful operation, of which number four are at work in the power station of the Sea-Shore Electric Railway at Asbury Park, N. J.

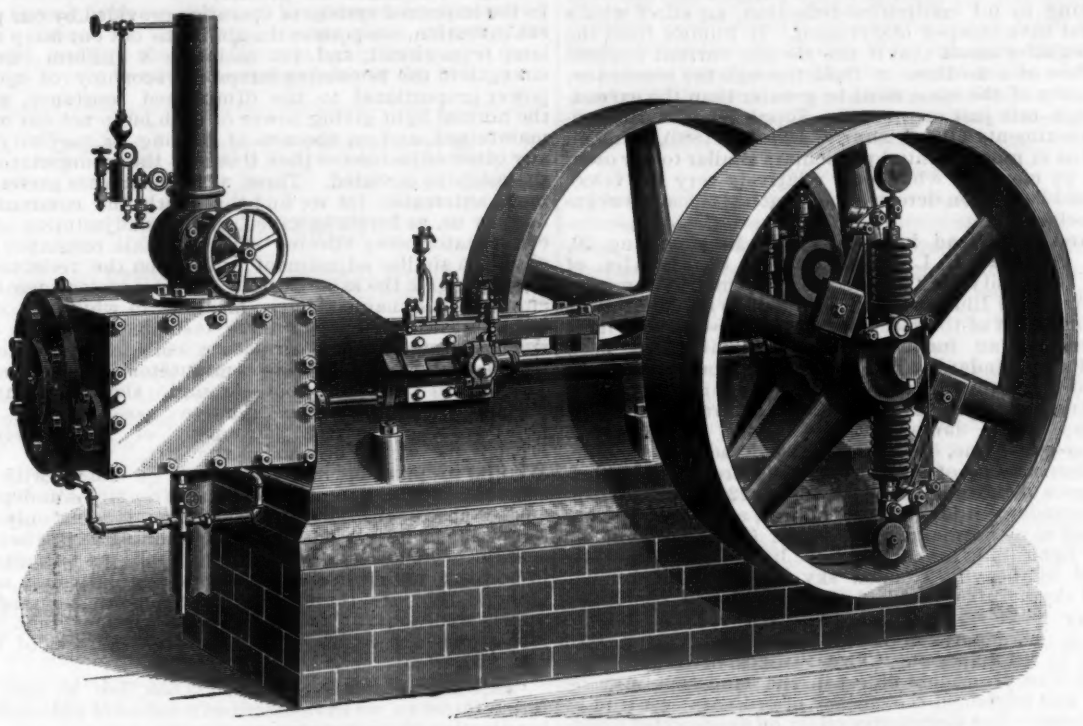


FIG. 1.—THE "DICK & CHURCH" AUTOMATIC ENGINE.

As will be seen in the engraving, Fig. 1, the bed is of the Tangye type, having an unusually large bearing and support on the foundation. It is massive in construction, having a liberal distribution of metal where strains are liable to occur. The forward end of the bed forms the front head of an overhanging cylinder. A feature of the bed is the arrangement for taking care of the oil escaping from the rubbing surfaces. The bottom interior surface of the bed, below the slides, is inclined towards the crank end, where the shape adopted forms a reservoir of considerable size. Into this reservoir the waste oil from the slides, the cross head pin, crank-pin, and from the inside of the main journals readily finds its way. On the outside of the bed, under the main boxes, are cast small pockets, into which the oil escaping from the outside of these boxes drips. From these pockets connections are made with the principal reservoir, previously referred to, by means of small pipes placed in the mould and cast in. Thus provision is made for gathering all the oil drip in the principal reservoir, from which it can be drawn at leisure, by means of a cock provided. This tends to keep the surroundings clean, and provides for saving the oil for future use, with little time and trouble. A depression at the cylinder end of the bed catches the water drip, keeping it separated from the oil.

In addition to the regular means of lubrication, the main journal caps are provided with covered chambers for tallow or other dense lubricant, that will melt should the oil cups fail to feed. For oiling the crank-pin a hole is drilled through it, longitudinally, other holes being drilled from the periphery of the pin to connect with this hole. An oil cup is mounted on the pillow block caps at each end of the pin. The cups are adjusted to feed regularly, and a metallic "cat's paw" wipes off the drop of oil and receives it in a pocket, whence it is carried by centrifugal force to the outside of the surface of the pin.

The main bearings are in halves, the lower half being cast solid with the bed. The bearings are lined with Babbitt metal, which is firmly hammered to place and bored by a special jig attachment to insure perfect alignment. Before being bored, however, the caps are separated from the lower halves of the bearings by Babbitt metal liners.

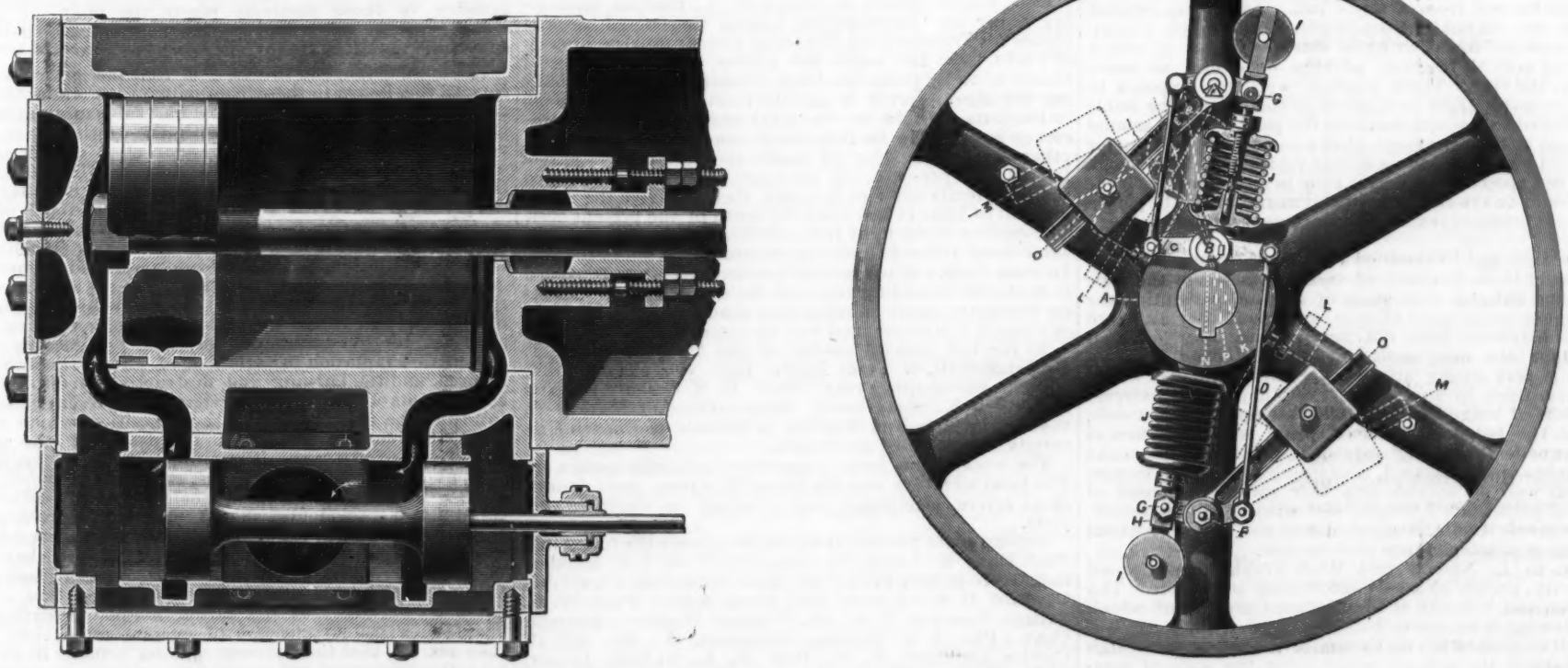
The crank shaft is a solid steel forging on which are placed counterbalance discs, which are securely fastened to the crank arms in a manner which renders it impossible for the discs to get loose.

The connecting rod is of hammered steel and the crank pin end is slotted out, leaving the top open for a loose piece, which, when in place, completes the space for the boxes. This arrangement makes it much easier to disconnect the rod, as there is no gib, key or U-shaped strap to remove. The loose piece is so locked to the rod end that the bolts holding it in place are not subjected to a shearing strain. The adjustment of the boxes is effected by means of vertical wedges having top and bottom bolts. The crosshead end of the connecting rod is slotted out for the boxes, so that the entire strap is integral with the rod. The boxes at the crank-pin end of the rod are lined with Babbitt metal, hammered solid and bored, while those at the crosshead end are of bronze.

The cross-head slides are of the locomotive type, on which the crosshead gets large bearing surfaces. The pin is at the centre of the crosshead, and is of steel with square projections at the ends fitting in corresponding recesses in the crosshead cheeks. The pin is held in place by means of a binding bolt, which prevents it from turning. The square projections on the pin take the thrust. The piston is packed by means of two sprung rings tongued together at the joint. To prevent any leakage, when the engine is new, the rings are sprung to nearly the size of of the cylinder bore, and are then finished to exact size, so that when they are sprung in the piston and placed in the cylinder an accurate fit is insured. The rings are made sufficiently wide to prevent any possibility of being caught in the ports, and they are accurately fitted to the sides of the piston grooves.

The valve shown in Fig. 2 is an improved form of the piston type, so designed and arranged as to overcome many of the disadvantages incident to the ordinary piston valve. Being placed below the centre line of the cylinder, so that the bottom of the cylinder and the ports drain back to the valve, the water of condensation is effectually removed during the period of exhaust. The valve is fitted to a removable case, arranged with the necessary steam and exhaust passages, and as this valve case is surrounded by live steam in the steam chest, equal expansion is ensured. When steam is first admitted to the steam chest expansion of the valve case takes place first, thus preventing the valve from sticking by being expanded against the case, and obviating entirely the trouble which frequently arises from the use of piston valves so arranged that the steam, being first admitted directly in the valve, expands and binds the valve against its casing. The absolute balance of the valve reduces the wear to a minimum, and although no packing rings are used on the valve they can be easily inserted should leakage result from long usage. The valve casing is so arranged that it can be easily removed and a new valve and casing quickly inserted.

The governor, Fig. 3, is of simple design, and, being situated on the outside of the balance wheel, is readily inspected and adjusted. By means of an independent shaft passing through the hub of the balance wheel, the eccentric is caused to travel across the main shaft, which varies the eccentric throw and automatically controls the steam supply to the cylinder. All parts of the governor are unusually light, thereby reducing the tendency to "carry past" under sudden changes of load. The springs, which resist the centrifugal force of the weights, are subject to compression instead of tension. At the centre of rotation of the weight-arms, knife-edge joints are employed in order to reduce the friction. The eccentric is counterbalanced by means of a suitable weight placed opposite on the independent shaft. The cylinder is jacketed with asbestos and neatly designed metal staves.



FIGS. 2 AND 3.—THE "DICK & CHURCH" AUTOMATIC ENGINE.

These engines are built by the Phœnix Iron Works (limited), of Meadville, Pa., and which have a branch office in this city in charge of Mr. H. C. White.

Prospect Park, Brooklyn.—The Executive Committee of the Prospect Park Commissioners, Brooklyn, has been authorized to ascertain what it would cost to procure and maintain an electric light plant for the park. The public sentiment in Brooklyn has been for some time in favor of dispensing with the ghastly naphtha lights used in the park and substituting electric lights. The committee is also authorized by the commission to engage an electric expert to prepare plans and specifications for the proposed improvements. It is estimated by C. J. Field, chief engineer of the Edison Manufacturing Company, that the total operating expenses of the system for one year will be $15,000, and the cost of necessary building and machinery between $55,000 and $60,000.

Meeting of the American Association for the Advancement of Science at Cleveland.

The meeting of the Association began at Cleveland on Aug. 15, on which evening the retiring president, Prof. S. P. Langley, delivered the customary address to a large audience, on the subject: "The History of a Scientific Doctrine."

The speaker reviewed the history of the doctrine of radiant energy generally, and especially that of radiant heat, and showed how, after the fall of many theories, through lack of experimental proof, the very old one that heat is a mode of motion stands well established to-day, while additional proofs are constantly being brought forward to confirm the truth of that doctrine.

Section *B*, that devoted to Physics, naturally received a good share of attention, and several papers bearing on electricity and kindred subjects were read.

Mr. C. J. H. Woodbury, of Boston, read a paper on "Protection of Watches against Magnetism," of which the following is an abstract:

It is surprising how weak a magnetic field will stop a watch, a small magnet being sufficient for the purpose; and far weaker magnetic fields will interfere with the rate of a watch to an extent which will injure its value as a timepiece. There are two types of attachments designed to protect watches against magnetism, one being a small disc of iron taking the place on the inner cover of a watch case, and the other a box or case surrounding the watch case, like the outer case of a bull's eye watch. Without indorsing any of the extreme statements declared to be fundamental principles of magnetism by those engaged in the sale of either of these devices, it is evident any magnetic body will distort lines of force in a magnetic field, and it was considered worth while first to submit the metal case to direct experiment. The magnet used was a small dynamo, containing cast iron to the weight of 450 pounds. The armature was disconnected from the circuit and the field coils connected to an electric circuit in order that the watches should not be subjected to a jar from a revolving armature. Remembering the engraving published in some of the electrical papers representing one of these cases in a magnetic field, and covered with iron filings bristling in all directions while filings inside were in repose, a circular piece of cardboard was placed in the case and dusted over with iron filings which had not been magnetized, and the box was closed and placed on a block of wood a foot from one of the poles of the magnet. An electric current sufficient to saturate the magnet passed through the field coils for a few moments, and the circuit was broken before the case was opened in order that the contents should not be directly exposed to any attraction except what was transmitted through the iron forming the case. On opening the case it was seen that the iron filings had been drawn toward one side of the card and arranged in striæ in the ordinary manner whenever they are exposed to a magnetic field. A watch which had been set to exact time with one in an extreme part of the room was placed in the case and in like manner exposed to the magnetic field for five minutes. When the case was opened it was found that the watch had stopped at the instant that the magnet was charged, and the movement had been magnetized to an extent which has robbed it of any present value as an accurate timepiece. At the same time a Waterbury watch exposed to the same conditions, except that an iron case was not used, stopped when the magnet was saturated, but started again apparently uninjured as far as can be learned from a day's run. As it was evident that the case did not adequately protect the watch, experiments were not made with the shield referred to, which contained a small fraction, perhaps one-tenth, as much metal as the case. These watches were not exposed to any more severe tests of magnetism than would be liable to be offered to a watch worn on the person of one around a dynamo or motor, except that a passenger in a motor car would naturally be in a sitting position, and the watch would be exposed for a longer time to any lines of force than would be the case around a dynamo, where the person would not probably remain in a stationary position so long a time.

Some time ago I examined a watch containing the inventions of C. A. Paillard, of Geneva, in which the hair spring and balance were made of alloy of palladium, the escapement being made of steel, and found that although a weak magnetic field did not produce any apparent effect upon the movement, yet it was stopped by exposure to a very strong attraction. This difficulty would be intermittent in its nature, even under the extreme conditions of magnetic force which stopped the watch, because the balance and hair spring were composed of non-magnetic alloys. Subsequently, when the same make of watches was produced, containing the whole escapement as well as balance and hair spring composed of alloys of palladium, I bought one subject to guarantee, and exposed it to the tests mentioned above without stopping it or interference with its rate.

Profs. E. L. Nichols and W. S. Franklin, of Cornell University, presented a very interesting paper on "The Direction and Velocity of the Electric Current," of which the following is an abstract:

A coil of wire of 390 turns was driven at a very high rate of speed, the axis of the coil being the axis of rotation. When the coil reached 338 revolutions per second, the linear velocity of the wire in the direction of its own length amounted to 8,000 centimeters per second. By means of two brush contacts at the axis a current was sent through the coil while the latter was in motion. The magnetic moment of the coil was determined by means of a very sensitive astatic pair of magnets carrying a mirror.

Readings were taken with the coil at rest and in revolution, the motion of the coil and the direction of the current being repeatedly reversed. If the electric current result from the flow of a fluid through the wire, in other words, if it may be considered as possessing direction and finite velocity, the influence of a motion of the conductor, with or against the current, should produce an appreciable influence upon the deflection of a magnet needle, even though the velocity of the current were very large as compared with that of the conductor. In order to render the detection of this presumably very small effect less difficult, the direct influence of the coil was eliminated by differential winding. Under these circumstances, when the coil was carrying as large a current as it could be made to do without injurious heating, the rotation of the coil was found to be without appreciable effect upon the magnetic moment of the same. The best results were obtained by sending 4.6 ampères of alternating current of 40,000 alternations per minute through the coil.

At a velocity of the wire equal to 8,000 centimetres per second they produced an effect upon the needle amounting to 0·2 millimetre deflection. The figure of merit of the coil and needle was determined by substituting a coil of continuous winding, its position with respect to the needle being the same as that of the rotating coil, and determining the current necessary to produce one centimetre deflection. The sensitiveness of the apparatus was found to be such that a current having direction and a velocity of 1,000,000,000 meters per second would have shown a change in its action upon the needle (when the motion of the coil was 380 revolutions, 8,000 centimetres per second), amounting to 0.1 centimetre deflection, an effect which could not have escaped observation. It follows from the above negative result that if the electric current consists in the flow of a medium or fluid through the conductor, the velocity of the same must be greater than the exceedingly high rate just mentioned. Foppl, who in some recent experiments (*Wiedemann's Annalen*, 1886), using an apparatus in most essential particulars similar to our own, but one by means of which only relatively very low velocities could have been detected, has reached the same negative conclusion.

The first paper read in Section *B* on Monday, Aug. 20, was by Professors E. L. Nichols and W. S. Franklin, of Cornell University, on "A Spectro-Photometric Comparison of Artificial Illuminants." It dealt with the results of a comparison of the spectrum of various sources of light with that of an incandescent lamp, which had been selected as a standard. The list of the sources of light included in the investigation are: (1) A standard candle, (2) a petroleum lamp flame without central draft, (3) a detroleum lamp flame with a central draft, (4) a batswing gas flame, (5) a "Board of Trade" gas flame, (6) an electric lamp of high voltage measured at five different degrees of incandescence—4, 10, 16, 22 and 28 candles, (7) an incandescent lamp of low voltage and large current measured at its normal candle power, (8) a lime light, (9) an arc light (long arc), (10) an arc light (short arc), (11) daylight by heavily clouded sky, (12) daylight by unclouded sky. Tables and technical calculation concluded the paper.

Prof. J. W. Moore, of Lafayette College, Easton, Pa., showed, in his paper on "Two Strokes of Lightning," that the least prominent object in the landscape may be struck, and explained the efficacy of ordinary cast iron as a conductor. The destructive effect on unprotected buildings was also described very fully by the professor.

In a short paper on "A Novel Form of Electro-Magnetic Telephone," Prof. R. B. Fulton, of the University of Mississippi, gave a description of a form of electro-magnetic telephone of his own design, in which the ordinary spool electro-magnet and circular diaphragm are replaced by a magnetized tube of thin sheet iron, with the insulated wire wound around the tube. The tube has a rectangular cross section about 2 inches square (it may be of any length), and open at one or both ends. It is magnetized by steel magnets, or a current, so as to have the lines of force running parallel to its length. The wire is coiled around those parts of the tube which form vibrating segments when vocal or other sounds are made near an open end of the tube. The lines of magnetic force, the direction of the vibratory motion of the walls of the tube and the direction of the induced currents are thus each at right angles to the other two. The instrument may be used either as a receiver or transmitter, but seems to work best as a transmitter to a Bell receiver.

Prof. Ernest Merritt, of Ithaca, N. Y., read an interesting paper on "Incandescent Lamps Considered as Machines for Transforming Electrical Energy into the Energy of Light." In the paper the author determines the efficiency of an incandescent lamp considered as a light making machine: that is to say, the ratio of energy given off in the form of light to the total energy used. This efficiency is found to be very small compared with that of other machines. For 16 candle-power lamps it varies from 4 to 6 per cent. If an incandescent lamp could be made perfectly efficient it would therefore give the same amount of light at less than one-tenth of the present cost. The quality of the light from different lamps and from the same lamp under different circumstances is found to vary. In some cases a much greater amount of energy is needed to make the same impression in the eye. The experiments on which the paper is based were made in the laboratory of Cornell University and will be continued.

At the last general session of the Association Prof. T. C. Mendenhall, of Terre Haute, Ind., was elected president for the ensuing year. Prof. H. S. Carhart, of Ann Arbor, Mich., was elected vice-president of Section *B*, that of Physics, and Prof. E. L. Nichols, of Cornell University, secretary of the Section.

The work of the local committee is highly spoken of. The local secretary was Dr. Elroy M. Avery, well known as an active electrician and a writer on electrical subjects.

Among those present at the meeting were the following: Prof. Elroy M. Avery, Cleveland, O.; Prof. T. C. Mendenhall, Terre Haute, Ind.; Prof. A. A. Michelson, Cleveland, O.; Prof. H. S. Carhart, Ann Arbor, Mich.; Prof. W. H. Bristol, Hoboken, N. J.; Mr. William Wallace, Ansonia, Conn.; Prof. B. F. Thomas, Columbus, O.; Mr. Alf. H. Cowles, Lockport, N. Y.; Prof. E. L. Nichols, Ithaca, N. Y.; Mr. C. J. H. Woodbury, Boston; Mr. J J. Walton, Philadelphia, Pa.; Prof. D. S. Jacobus, Jersey City, N. J.; Mr. Edwin Place, New York City.

The next meeting of the Association will be held at Toronto, Can.

The Dynamo Current Regulator Decision.

CIRCUIT COURT OF THE UNITED STATES. DISTRICT OF MASSACHUSETTS.—IN EQUITY.

Thomson-Houston Electric Company v. Citizen's Electric Light Company et al. No. 2343.

OPINION OF THE COURT. (AUGUST 14, 1888.)

COLT, J. This suit is brought for the infringement of letters patent No. 238,315, granted Elihu Thomson and Edwin J. Houston, March 1, 1881, for improvements in current regulators for dynamo-electric machines. The specification says:

"The object of our invention is to provide improved means for controlling automatically the strength of an electric current flowing over a circuit composed of a dynamo-electric machine and one or more electric lamps, or other appliances, through which the current passes, and to obtain said control without the introduction of resistances as such, and without varying the speed or field of the dynamo-electric machine, and at the same time, if desired, to utilize the reaction principle for the magnetization of said dynamo-electric machine, or in other words, to cause the current generated to pass through the field-magnet coils. We accomplish these results at the same time that the power expended to drive the dynamo-electric machine varies directly in accordance with the changed resistance of its circuit, being less as the resistance is less, and greater as the resistance is greater. * * * * * In the improved system of operation provided by our present invention, we possess the ability to cut out lamp after lamp from circuit, and yet maintain a uniform current strength in the remaining lamps and economy of motive power proportional to the diminished resistance, while the normal light-giving power of each lamp not cut out is maintained, and an absence of heating or necessity for any other adjustments than those at the commutator of the machine obviated. These adjustments are preferably made automatic, for we find that with the commutator used by us, as herein specified, a proper adjustment of the commutator being effected when a certain resistance is in circuit, a similar adjustment will, when the resistance is changed, give the same current. In our system we have employed a dynamo-electric machine in which the commutator is constructed of three insulated segments of a ring connected to three armature coils. The collecting brushes applied to said commutator are supported so as to be movable around the commutator without changing the relative positions of the two collectors. This movement of the collecting-brushes is well known in the art. * * * * * We find in practice, moreover, that we obtain with this automatic regulation of the current strength an independence of speed-variations in the machine, it being only necessary to so adjust the speed of running that when the speed is at its lowest the machine shall yet be sufficient in power to maintain the number of lights placed in its circuit. We are therefore able to operate successfully under conditions of motive-power variations that have hitherto been recognized as fatal to steadiness of light obtained.

"In United States Patent No. 223,659, Jan. 20, 1880, before referred to, we have described a means of automatically adjusting the commutator-collectors of dynamo-electric machines, which method is adaptable to the present case of current regulation. * * * * * * * Our present method of operating, therefore, so far as it relates to automatic regulation, is based upon the same principles of operation as our previous invention; and it consists in an improved construction and mode of use of the apparatus employed in patent No. 223,659.

"We claim:

"1. In a current regulator for a dynamo electric machine, the combination of a device responding to changes in the main or generated current, a shifting commutator for said machine, and mechanism controlled by said responsive device to shift the commutator to those positions where the current taken up by said commutator shall be constant.

"2. In a current-regulator for a dynamo-electric machine, an electro-magnetic device acted upon by variations in the main or generated current, an adjustable or shifting commutator for the machine, and mechanism controlled by said electro-magnetic device to adjust the commutator to those positions where the main or generated current taken up by said commutator shall be constant."

The main defence in this case is that the prior patent No. 223,659, issued to these complainants, is an anticipation of the patent in suit. Upon careful examination of the two patents in connection with the testimony of experts and the able arguments of counsel, I cannot agree with the position taken by the defendants. The object of the two patents, as disclosed by their titles, is different; the patent in suit is for a current regulator for dynamo machines, the earlier patent is for an automatic adjuster for commutator-brushes on magneto-electric machines. Current regulation, or "to provide improved means for controlling automatically the strength of the electric current," is the object of the patent in suit, while the object of the prior patent was the construction of an automatic adjuster for commutator brushes, "whereby an automatic adaptation to variations of circuit resistance is secured, and the burning and destructive effects of false adjustments obviated." The design of the present patent is to adjust the commutator to those positions which shall keep the current constant; the design of the prior patent was to adjust the commutator so as to keep the current at its maximum value, or in other words, to adjust the brushes so that their contacts with the commutator segments should be at the neutral points, by which means the difficulty from sparking would be reduced to a minimum. It is true that the means employed in both patents to accomplish these different results bear a close relation to each other. The patentees declare that the earlier method described is adaptable to the present case of current regulation, but they also say that their present method consists in an improved construction and mode of use of the apparatus employed in the prior patent. To construct an automatic adjuster which shall avoid sparking or leakage by bringing the brushes in contact with the commutator segments at the neutral line, or the points of the maximum difference of potential between the segments, and therefore, of maximum current, may be an important invention, but it is certainly quite a different invention to adjust the brushes of the commutator to positions which shall keep the current constant, independently of the question whether the brushes touch the segments at the neutral points, or whether sparking is avoided.

It is said that the present invention is shown in Figs. 1 or 2 of the earlier patent. The testimony of defendants' experts seems to find the invention described in Fig. 1, while the learned senior counsel for defendants appears to reject this contention and turns to Fig. 2 as an anticipation of the patent in suit. I do not find in Fig. 2 of the earlier patent the combination of mechanism which forms the subject matter of the claims of the patent now under consideration. I do not find that which constitutes the important thing in the present invention, namely, the responsive device responding to changes in the main or generated current. In respect to Fig. 1, the most that can be said is that it im-

perfectly describes that which was perfected in the subsequent patent now in controversy. It seems to me in other words that the language of the specification is strictly accurate where it declares that the present invention "consists in an improved construction and mode of use of the apparatus employed in patent No. 223,659."

Upon the subject of infringement I have no doubt. The question is not as to the form of dynamo the defendants may use or whether their machine may be adjusted by hand to avoid sparking, but the question is whether they use the complainant's invention by the employment of substantially the same means to accomplish the same result, namely, the regulation of the current by means of a device responding to changes in the main or generated current, and this the complainants have shown.

Let a decree be entered as prayed for in the bill.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
168-177 POTTER BUILDING, NEW YORK, Aug. 27, 1888.

The Lahmeyer Dynamo.

Mr. E. Imhauser, 106 Broadway, has just sold one of his Lahmeyer dynamos to the Mount Morris Electric Light Company, for their station at 219 Washington street, this city, where it is furnishing 35 lights of 110 volts, ½ ampère, Sawyer-Man 16 c. p. lamps, for use in adjoining restaurant, butcher's shop, etc. Another of these machines has just been installed in the Hotel Belvedere, 18th street and 4th avenue, by Mr. P. Claus, where it is running 120 Sawyer-Man lamps, 16 c. p., at 110 volts, as well as 2 arc lamps. A number of these machines are now in use in this State and other parts of the country. A testimonial recently received from the Mining and Milling Company at East Liverpool, O., where one of their machines is running two magnetic separators, a 1,200 c. p. arc lamp and 30 incandescent lights of 32 c. p., praises the machine for its great smoothness and coolness of running, and its freedom from any leakage of the field.

Electric Gas Lighting.

Mr. A. L. Bogart, 22 Union Square, this city, has lately been engaged in some very extensive installations of his celebrated electric gas lighting apparatus. One of the large pieces of work now on the way is that at the Cathedral of St. Patrick on Fifth avenue, where he will put in no fewer than 1,400 porcelain electric gas lighting burners. These will all be lighted from one of his new and improved friction machines. The burners can be lighted in groups or in one batch, as desired. The carrying out of this piece of work will require some very ingenious construction, as the interior decorations of the fine cathedral are not to be disturbed.

One place where Mr. Bogart is to do some of his excellent work will be the remodeled Academy of Music, in Fourteenth street, which will have 1,000 of the porcelain burners when the plant is complete. Mr. Bogart is also engaged in making a very handsome cut glass chandelier for the Academy, and it is said that when finished there will be only one like it in the country for beauty and elaborate ornamentation. All the gas burners within it will be lit by electricity. A third big installation on which Mr. Bogart is busy is the new Tammany Hall and Tony Pastor's Theatre, in Fourteenth street. This will contain 1,400 burners. It will be seen that, although this is summer time, Mr. Bogart is busy; for it must be remembered that these large orders are supplemented by an endless number of smaller ones for residences and places of public resort. I might mention that Mr. Bogart showed me the other day some very handsome scenic lights made especially by him for Tony Pastor's Theatre, the object being to protect the scenes from any possible contact with the gas. They are so constructed as to reflect the light down where it is needed and at the same time to avoid overheating the tin reflectors. Mr. Bogart has long been noted for his original and inventive genius, being one of those men to whom you can describe by word of mouth any of the most intricate pieces of mechanism, and he will be capable of giving you a perfect working machine; and some of his late work has given him an opportunity of displaying his talents in this line.

Work in the West.

Mr. A. J. Mears, the electrician and representative of the Interstate Electric Company, of Kansas City, was in town last week, attending to various additions to be made to the work of his company, and also to the purchase of electric lighting supplies for some big installations now in course of construction. He tells me that the company are building a large accumulator plant at Missouri Valley, Iowa, which will comprise 66 accumulators in two series, running in connection with a Fort Wayne Jenney machine and 300 Sawyer-Man lamps. There is already talk of increasing the plant.

Orders for the Empire City Company.

I am reliably informed that the Empire City Company have engaged space for no less than 50 tons of electrical supplies on board the steamer for Valparaiso, and that other large cargo space has been booked on the steamer for Talcahuano. The demand for the goods of the company is beyond their most sanguine expectations, and I am very glad indeed to note this extension of our export trade.

Yacht Accumulator Plant.

Mr. Charles Benton, the Edison agent, tells me that the Isolated Accumulator Company has just furnished a storage battery plant to the "Nourmahal," Astor's beautiful steam yacht, for a 75-light plant on board. He has himself just closed a contract for a plant of 200 Edison lights for E. J. Larrabee & Co.'s new cracker backery, on West Fifteenth street, the order to be filled by the Edison United Manufacturing Company.

Cotton Leather Belting.

Mr. A. B. Laurence, 82 John street, the New York agent of the Cotton Leather Belting, has been wonderfully successful in the introduction of these belts all over the country as well as abroad. I hear that he has just shipped to Costa Rica, for San Jose, the capital, some 330 ft. of 6, 8 and 15-in. belts for the new Thomson-Houston arc plant which is to be installed there by a syndicate. Williams & Potter have also ordered 40 ft. of 9-in belt to be used for a plant they will install in Japan. Another order from this same concern is for belting to run a Straight Line engine on the Edison plant at Archibald Rogers' fine residence at Hyde Park on the Hudson. Other orders include one from the United States Illuminating Company for their plant in the Post Office here and one from the C. & C. Motor Company to run the big organ in St. Paul's Church, Vesey and Fulton streets.

The Mather Company.

Mr. Beane, the well-known representative of the Mather Company, has just closed a heavy contract for 700 lamps and 2 dynamos, to be installed in the Amberg Theatre, better known as the old Irving Hall, in this city, which has been renovated and made into a beautiful home for the German drama. Special apparatus will be put in for controlling the lamps, so that all the lights may be manipulated from the prompter's desk. The demand for Mather plant continues steady and brisk.

Electrical Accumulators.

I had the pleasure of meeting last week Mr. Charles Truex, the assisstant general manager of the Electrical Accumulator Company, 44 Broadway, just after his return from his trip through the East. He reports an exceedingly good demand for accumulators from his Eastern agents, and many notable installations are now being made in private residences and on board yachts, etc.

Hazaser & Stanley.

This enterprising firm of 32 and 34 Franklin street have just issued a very tasteful and extensive catalogue of electrical apparatus and supplies. It fills no fewer than 32 pages and is exceedingly well arranged and illustrated. It includes all the well-known specialties of the firm, such as annunciators, batteries, push buttons, door openers, speaking tubes, floor pushes, gas lighting apparatus, iron box bells, medical apparatus, electric motors, telegraph instruments, window screens and wires of all kinds. The firm find themselves remarkably busy, and report the outlook for the fall trade as exceedingly good.

Sprague Motors and Railways.

In connection with the description of the Edison machine works at Schenectady, printed last week, it is interesting to notice the progress which the Sprague motors are constantly making in the railroad and industrial field. Although the Sprague Company has a factory on Thirtieth street in New York, only a small portion of their work is done there, and the bulk of the business of construction is carried on at Schenectady. The Sprague Company has now in operation or in process of construction street railroads in twenty-three different cities or towns in the country, and they are rapidly contracting for others. Among the roads which have been put in operation during the past month may be mentioned the Naumkeag street railway of Salem, Mass., and the East Davenport street railway of Davenport, Iowa. Both of these roads are running very successfully, and the president and directors of both express themselves as being very well pleased with their new electrical equipments. Work on the machinery of the electrical equipment for the West End Street Railroad Company, of Boston, is being rapidly pushed forward, and will soon be ready for installation. The overhead structure will be of the most neat and tasteful description. The poles will be of iron of some ornamental pattern, and will be set in concrete. These will carry the light and small No. 6 overhead wire which is used upon all the Sprague roads. The power station will be placed at Allston, on the Boston & Albany Railroad, and will have both water and rail facilities for receiving fuel. The dynamos will be of the largest size and of the Edison pattern. The first part of the equipment will consists of 20 cars, which will all be ready for operation by Oct. 1. The Manchester & Richmond Street Railway Company has contracted with the Sprague Company for the equipment of its 10 cars by the Sprague system. This will make *three* roads and 100 cars which the Sprague Company will have in operation in that one city alone. At St. Joseph, Mo., the successful operation of the Sprague system on the road of the Union Railway Company has been so marked that the Wyatt Park Railway Company, of that city, has decided to adopt Sprague motors and overhead wiring upon its cars. The Union Railway Company has also contracted for an extension of the Sprague system upon its road. Two other street railroads now using the Sprague system over part of their roads have decided to extend it over the whole. These are the Wilmington City Railway Company, of Wilmington, Del., and the Wilkesbarre & Suburban Railway Company, of Wilkesbarre, Pa. They have both been in operation for about three months, and have been giving perfect satisfaction. The first equipments of these were three and four cars respectively. The work on the electrical equipment for the Brockton, Mass., East Side street railway is being pushed forward as rapidly as possible. The Sprague overhead system of wiring will be used and all the latest improvements will be adopted. It is expected that this road will be in operation by the first of September. The committee appointed by the city council of Akron, Ohio, to investigate the subject of electrical railway propulsion, has advised in favor of the Sprague system. They visited every successful electrical railway in the country, and the operation of each was inspected. In their report the committee stated that they were fully satisfied from their investigations that the Sprague system was superior to all others, and consequently the contract for equipping the road in that city has been given to the Sprague Company. The equipment will consist of twelve cars. The East Cleveland, Ohio, Street Railway, operating 160 cars and owning 650 horses, has, through its president Dr. A. Everett, contracted with the Sprague Company for the electrical equipment of that important street railroad. It is the largest street railway in Cleveland and its indorsement of the electrical system of street car traffic is most gratifying to all those interested in electrical application. Among the many points of superiority of the Sprague system for street car propulsion there may be mentioned its system of conducting current to the cars, with the impossibility of an accident at any point of the line interfering with the operation of the remainder of the road; its system of using one motor on each axle of the car, controlled by a single switch, and its method of flexibly suspending motors from the axles to secure perfection of running.

The success which the Sprague motor is making in stationary work is no less marked than in railroad applications. There are Sprague motors in operation in over 100 cities and towns in this country, and they have been shipped abroad to England, Germany, France, Italy and Japan. During one week in July there was 1,250 horse-power of motors sold. The Sprague Company have recently been building some smaller sized motors of ¼ and ½ horse-power each. These are wound for 110 volt circuits, and will meet with a ready sale for small fans, models and other apparatus where but little power is required.

The Daft Road at Asbury Park.

People who cling to the tradition that electrical propulsion is still in the experimental phase must have this conviction thoroughly disturbed by an evidence of its commercial capacity revealed at Asbury Park, N. J., on Aug. 14—the day of the Republican Convention of the State of New Jersey. The Daft Electric Light Company were formally notified the following day by the Superintendent of the Seashore Electric Railway (Daft system) that 15,000 passengers were carried on Convention day without the slightest accident of any kind whatever, and with no delay. This was done with 16 Daft motor cars, each of which therefore carried nearly 940 passengers. How many horses would it have required to do this work? One thing is very certain, viz.: that to do it daily with the usual per centage of invalidism in a horse railway stable, would bring the total number up to 200.

The Subway Board.

Attorney General Tabor of this State has declined to bring any suit against the New York U. S. Illuminating Company, on the ground that the city itself now has such a suit pending. The Subway Board is now endeavoring to get the wires concentrated upon fewer poles, in thoroughfares where there are no conduits.

Callender Underground Cables.

The Callender Insulating and Waterproofing Company have issued a circular containing a number of replies from Edison stations to a telegram, inquiring as to the results obtained with their underground cables. In each case the reply bore testimony as to the satisfaction given by the cables and the places in question were such as Cincinnati, Detroit, Columbus, O., etc.

The E. P. Gleason Company.

The well-known concern of E. P. Gleason Manufacturing Company, of 181 to 189 Mercer street, are steadily making additions to their already wonderfully large line of electric light fittings and appliances in all the various metals. As is well known, this house was a pioneer in the gas fixtures business, and has applied the results of its long years of experience to the new requirements of the electric lighting trade with really remarkable success. Many of these fittings and special fixtures are extremely ingenious and thoroughly well calculated to answer the purposes for which they are designed—that of safety to person and property from fire or shock—and insuring the stability and freedom from breakage of lamps and globes. Their catalogue of electric light specialties is already an extensive and comprehensive production, not yet so large as their gas catalogue, which runs hundreds of pages, but still large enough to show that every possible necessity has been thought of and studied, and advantageously met. In addition to carrying a very large assortment of fixtures and appliances, the company have also shades and globe holders, lanterns and very fine glass in all the new varieties that fashion and the modern dictates or ideas as to beauty call for.

W. T. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
178 Devonshire Street, Boston, Aug. 27, 1888.

Personals.

Mr. S. A. Duncan, of Pittsburgh, Pa., the president of the National Electric Light Association, and identified with several electrical enterprises, was in this city last week and favored this office with a visit.

Mr. Thomas Wallace, Jr., of Ansonia, Conn., secretary of the Electrical Supply Company, was in Boston on Monday of last week, and afforded me the pleasure of his presence at this office.

Mr. Henry D. Stanley, of the Bridgeport Brass Company, accompanied by his brother-in-law, Mr. Geo. D. Martin, made me a very pleasant call on Tuesday of last week.

Mr. A. K. Hobby, of New York, representing the John A. Roebling's Sons Company, Trenton, N. J., was in Boston during last week on a flying business visit. I was very much pleased to receive a visit from him.

New Branch Office.

The Brush Electric Company, of Cleveland, Ohio, has established a branch office in Boston at No. 113 Devonshire street. Mr. C. S. Haley, the company's New England agent, will make the Boston office his headquarters when not on the road.

Electric Street Railway at Lynn.

The electric railroad of the Lynn & Boston Company will be completed in a week, and cars will be running by the 1st of September. The Highland residents, through whose district the road runs, will probably celebrate the event with a demonstration.

Addition to the Thomson-Houston Factory.

The Boston *Herald*, Aug. 21, contained the following: The Thomson-Houston Electric Company of Lynn has purchased, through Silsbee & Geer, real estate agents, the Otis Johnson estate on Federal street in that city, comprising 150,000 square feet. The company will use this land to accommodate its rapidly increasing business.

Combination of Gas and Electric Lights.

The New Bedford Gas Light Company increases its capital stock to $300,000, an addition of $50,000, in order to do more business with electric lights.

Jarvis Engineering Company.

During the past six months the Jarvis Engineering Company have equipped more than twenty-five electric light and power stations with complete steam plants, comprising Armington & Sims engines, belting direct to the dynamos, steel boilers set with the Jarvis patent furnace, Sheffield grate bars, National feed water heaters, Korting injectors, and their other special appliances: Chelsea, Mass., Gas Co.; Somerville, Mass., Electric Light Co.; Quincy, Mass., Electric Light and Power Co.; Palmer, Mass., Electric Light Co.; Edison Electric Illuminating Co., Newport,

R. I.; Malden, Mass., Electric Co.; Meriden, Conn., Horse Railway Co.; Burlington, Vt., Gas Light Co.; Newport, R. I., Incandescent Electric Light Co.; Cambridge, Mass., Electric Light Co.; Syracuse, N. Y., Street Railway Co.; North Shore Electric Light Co., Beachmont, Mass.; Narragansett Pier, R. I., Electric Light Co.; Dover, N. H., Electric Light Co.; West End Street Railway Co., Boston, Mass.; J. O. Proctor, Gloucester, Mass; Osaka Electric Light Co., Osaka, Japan; Seattle, W. T., Electric Railway and Power Co. They have set during the same time 250 boilers with the Jarvis patent furnace, and sold 58 Armington & Sims engines, aggregating forty-five hundred horse-power.

The New England Electric Exchange.

The Electric Exchange is systematically carrying out the work which it has undertaken, and the success of its plan of licensing has become an accomplished fact. To provide for the increased number of applicants, it has again been necessary to increase the number of examiners, and as the New England Insurance Exchange is again calling attention to the fact that on and after Oct. 1 it "will require that all persons engaged in installing and operating electric light and power apparatus shall hold a license from the New England Electric Exchange," the directors have decided, in order that all may be examined with the least possible inconvenience and loss of time to the applicants, that examinations shall be held at New Haven, Conn., Sept. 12; Waterville, Me., Sept. 19; Bellows Falls, Vt., Sept. 26, in addition to the regular Wednesday examinations in Boston. As soon as possible after the applications are received the applicants are notified when and where they can be examined.

Electric Railway at Salem.

Among the best equipped and most successfully operated electric street railways in the New England States is the "Willows' branch road of the Naumkeag Street Railway Company at Salem, Mass. This road is 1¼ miles in length, with double tracks about one-half that distance. At present six electric cars are in operation. Each car is equipped with two Sprague motors of 7½ h. p. each. The overhead contact system is used and the power is temporarily furnished by the Adamanta Works. The construction of the car equipment (including trolley and all the connections), and the poles and wiring as well, are identically the same as on the electric railway at Richmond, Va.

The "Willows" branch road has several steep grades, and there are numerous sharp curves along the route, some of the latter being on the steepest parts of the former. The electric cars find that neither the grades nor curves act as impediments. They pass over these with 75 passengers at a six-mile gait without any trouble. I am indebted to Messrs. Sawyer & Blake, of Boston, the N. E. agents of the Sprague Electric Railway and Motor Company, for a delightful ride over the road on Tuesday, Aug. 14. To these gentlemen is due the credit of introducing the electric motors on the Salem street railway cars. Prominent street railway people from various sections of New England have visited Salem recently and carefully inspected the electric system used on the Naumkeag road, and in every instance they have expressed admiration at the successful working of the "Willows' branch.

W. I. B.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
39 South Tenth Street, Philadelphia, Pa., Aug. 25, 1888.

New Companies.

Among the charters granted at the State Department at Harrisburg this week was one to the Homestead Electric Light and Power Company, of Allegheny County, with a capital stock of $10,000; and one to the Edison Illuminating Company, of Easton, with $50,000 capital.

The Demand for Glass.

The Westinghouse people are large patrons of the Standard Flint Glass Works, of 1,207 Arch street, this city, which speaks well for the high quality of glass goods turned out by Mr. Kuemmerle, the owner of the works. The United States and other large companies also use the bulbs manufactured by this house.

Millville, N. J.

Superintendent Foster, of the Schuyler Electric Light Company of Millville, N. J., was last week held for trial by Justice Hall, in Vineland, to answer a charge of having illegally removed the wires and dynamo of the plant in Vineland. It is alleged that a gang of men removed the plant before daylight a week ago Saturday under Superintendent Foster's direction.

Camden, N. J.

The Lighting Committee of the Camden (N. J.) city council met last Thursday night and ratified the proposition by which the Camden Heating and LightingCompany agrees to place along the streets fifty or more electric lights at a cost of fifty cents each per night. The lights are to be of 2,000 candle power. Thirty-seven lights are now in use and fifteen more will be added, making fifty-two in all. The contract with the Camden Gas Company remains unsigned, owing to the vigorous opposition by that corporation to the placing of more than thirty-six electric lights. It is easy to see who will be the victor.

The McLaughlin Electric Typewriter.

J. F. McLaughlin, of this city, was granted final patents for his electrical typewriter last week. The machine is said to be almost perfection itself.

J. W. Queen & Co.

Owing to a recent city ordinance, widening Chestnut street between Ninth and Tenth, the large store of Messrs. J. W. Queen & Co. will have to be set back seven feet, or rather the front wall will have to be moved that distance. While it will be somewhat inconvenient for a short time, business will go on as usual.

Taylor Engines.

The Taylor Manufacturing Company, Chambersburg, Pa., report the following recent sales of complete steam plants and Beck automatic engines for electrical service: 14½ × 18 engine and 72-inch boiler to the Huntington Electric Light and Street Railway Company, of Huntington, W. Va.; a 13 × 15 automatic engine with 66-foot boiler to the Newark & Granville Electric Street Railway Company, of Newark, O., for operating electric railway; 13½ × 15 automatic engine with boiler to the Schuyler Electric Company, for Mt. Vernon, O.; 11½ × 15 automatic engine with boiler to the Thomson-Houston Electric Light Company, of Meridian, Miss.; 8½ × 10 automatic engine and boiler for operating Edison plant at Port Deposit, Md.; 12½ × 15 automatic engine for Congaree Electric Light and Gas Company, of Columbia, S. C.; 12½ × 15 automatic engine for the Thomson-Houston Electric Light Company, of Macon, Ga., and an 8½ × 10 automatic engine for the Fleishman building, Pittsburgh, Pa. The Taylor Manufacturing Company pay particular attention to steam plant construction and complete installation, and claim to do superior work in every respect.

Opening the Streets for Subways.

As the city laws forbid the opening of streets during the latter part of Fall and during the Winter months, the electric light companies who have their wires under ground are doing an extraordinary business in the way of making contracts for the supply of light, so that all the connections and service wires may be finished before the law begins to operate.

Wires in the Storm.

The telegraph, telephone, and electric light wires suffered greatly by the heavy storm of last week. Especially was this the case at Wilmington, Del., where the lines which were in the path of the cyclone which visited that place were completely demolished. Extra forces soon repaired the damage, however.

E. W. E.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
44 Lakeside Building, Chicago, Aug. 25, 1888.

Train Lighting by Electricity.

Mr. A. H. Bauer, electrician of the Pullman Palace Car Company, informs me that his company have recently equipped with electric lights the train on the Pennsylvania road known as the Pullman vestibule train. The light produced is clear and beautiful and the system operates successfully in every particular. Mr. Bauer will start out two more trains to New York in about ten days.

New Installations.

The Western Department of the Thomson-Houston Company report recent sales of electric light apparatus to the following: The Arkansas City Gas Company, of Arkansas City, Ark., 35 arc lights; North Chicago City Railway Company, of Chicago, 50 arc lights; Kansas City Exposition, of Kansas City, Mo., 200 arc lights. The latter plant will be in operation in September.

The Central Electric Company.

I dropped in to see the Central Electric Company last week, and found them, to use the words of the cordial secretary, W. H. McKinlock, "head over heels" in very large orders for Okonite and Candee wire. Mr. McKinlock is confident that the fall trade boom is near at hand.

Mr. Foree Bain,

electrical engineer, who makes a specialty of special machinery, received a large order this week for the construction of some special work, including dynamos and other electrical apparatus.

The Electrical Supply Company.

The Electrical Supply Company report a very large number of sales during the past week of P. & B. wire, also a very large and increasing demand for their commutator conserver for use on commutators to prevent sparking. Mr. Taylor tells me that people who order samples invariably send an order afterward for a large quantity, as it "fills the bill."

The Indianapolis Jenney Company.

Among the recent sales of the Jenney Electric Company of Indianapolis are a 60-light arc outfit, including power, to the Coshocton, Ohio, Gas Company; 30-light arc outfit to Julius Balke and others, of Cincinnati; an additional 80 arc lights to Topeka, Kan.; 80 arc lights to the Sullivan Electric Light and Power Company; 80 arc lights to "The Order of Cincinnatus," Cincinnati, and a large number of incandescent plants from thirty to six hundred lights each.

The Ziegler Elevated Railway.

Capt. Ziegler, inventor and patentee of the system of elevated roads bearing his name, is in the city this week for the purpose of introducing his system upon the roads which are now being projected. It is stated that this system has received the warm endorsement of Cyrus W. Field and others interested in elevated roads in the East.

The Stock Yards Electric Light Plant.

The *Tribune* of Aug. 13 contains the following: What is supposed to be the most complete electric light plant in the country is now in operation at the Union Stock Yards, usually so dark and forbidding. The experiment which has cost about $12,000, proves to be successful. Considerable of the stock received at the yards is unloaded at night, and the danger in unloading is great. There is also a good deal of switching done. No part of the yards is now in darkness. There are 70 lights supplied by two dynamos. Fifty-two are in use at present. The lights are brilliant, steady and economical. They extend from Winter street to Ashland avenue along Fortieth street. There is a cluster of lights upon a tower in that part of the yards where most of the work is done. The tower is 120 feet from the ground and may be seen from a great distance.

To Lubricate Exposition Dynamos.

Mr. S. Taussig, agent for the "Synovial" dynamo and cylinder oils, informs me that he has received an order from the Western Electric Company to supply the oil for running the two plants which will be in operation next month at the St. Louis and Chicago expositions.

Subway Conduits.

The National Subway Company, of this city, has awarded the contract for two Gibbs improved automatic electrical conduit machines, having a daily capacity of 1,000 feet, to Chas. Kaestner & Co., of this city. These machines will be used in making the electrical subways now being laid by the company in Minneapolis, where they are putting in 60 miles of underground conduits.

The Phonograph.

The Illinois Phonograph Company have on exhibition at 42 La Salle street two phonographs which attract much attention from a large number of people.

The Lima Electric Road.

The Lima, O., Electric Street Railway Company have substituted the link belt manufactured by the Link Belt Machinery Company, of Chicago, in place of that formerly used in their motor cars, and I am informed that it works very satisfactorily.

Meridian, Miss.

The Thomson-Houston Electric Light and Power Company, of Meridian, Miss., has been organized. Seventy arc lights have just been ordered from the Western branch of the Thomson-Houston Company.

Fargo, Dak.

The Fargo Incandescent Electric Light Company, of Fargo, Dak., are just putting in a plant of 500 incandescent lights of the Thomson-Houston system.

Kansas City.

The Kansas City Electric Light Compay, of Kansas City, Mo., are increasing their plant with 50 arc lights just ordered from the Thomson-Houston Company.

St. Louis, Mo.

Messrs. J. H. Siegrist, Jr., & Co., of St. Louis, Mo., write me that they have taken the agency of the Phœnix Iron Works for their well-known Dick & Church high-speed engine. This firm are now putting in a 12 x 12 engine at the St. Louis Exposition to drive the arc lights. This firm are also the agents for the Brightman stoker, for which they report a good demand.

New Corporations.

The Secretary of State has issued incorporation licenses during the week to the following:

The Lowth Stetho-Telephone Company, Chicago; capital stock, $5,000,000; incorporators, James Lowth, Edwin T. Brown, Jr., and Allan C. Knapp.

The People's Light and Power Company, Chicago; capital stock, $100,000; incorporators, Charles P. Dose, John F. Buhmann and Charles C. Fricke.

The Edgewater Light Company, Chicago; capital stock, $60,000; incorporators; John Lewis Cochran, S. Wilmer Carmel and John Scovel.

The People's Outfitting Company, Chicago; capital stock, $45,000; incorporators, Henry H. Kennedy, Bernard A. Smith and Andrew Gillespie.

A Directory of Arc Lighting Plants.

The National Carbon Company have just compiled and issued, with their compliments to the members of the National Electric Light Association, a very handy and useful directory of arc lighting plants. The company sent out no fewer than 3,000 circular letters of inquiry in June last to that number of plants, asking for information, and the pamphlet, running a length of about 100 pages, is based on the replies. The plants are grouped by States, and in each case the details are given as to number of lamps, commercial lighting, street lighting, etc., with the name of the system used. The company also take the opportunity of giving some very interesting information as to the details of their own industry. They are now making, with the latest and best machinery, molded, forced and cored carbons, of all the usual sizes and for all the systems extant. For the Cowles electric smelting process at Lockport they are furnishing carbons 2¼ × 50 inches in length, bound in bundles of seven, and they have also made for the same works carbons 6 inches in diameter. They have also supplied the government for the Statue of Liberty, as well as for experimental purposes, with special cored carbons, with or without filling, from $\frac{7}{16}$ to $\frac{5}{8}$ in. diameter. Their productive capacity has been doubled in the last year, and, is now equal to nearly 4,000,000 carbons per month. Mr. W. H. Lawrence, the president of the company, is a veteran in the arc lighting and carbon business, and has seen the demand grow from the beginning until the present time, when carbons have become a staple commodity.

Telephone Quotations.

Col. S. G. Lynch, broker, 146 La Salle street, furnishes quotations upon telephone stock as follows:

Bell of Mo.	$150	@$155	Iowa Union	$27	@ $28
Central Union	47	@ 48	Michigan	79	@ 80
Chicago	340	@ 345	Missouri and Kansas	70	@ 71
Colorado	44	@ 47	Rocky Mountain Bell	40	@ 45
Cumberland	65	@ 68	Wisconsin	110	@ 112
Great Southern	35	@ 40		E. L. P.	

BUSINESS NOTICES.

The Bernstein Lamp.—The Bernstein Electric Lamp Company, Limited, of London, have issued a notice that on and after Aug. 11 their offices will be at 2 Marlborough Mansions, Victoria street, London, S. W.

Jordan & Gottfried, 208 Canal Street, N. Y., carry a complete stock of iron and brass machine and wood screws, bolt, cap and set screws, taps, dies, files, twist drills, brass and rubber tubing, rod and sheet copper, brass, German silver, steel and iron wire, shafting, tools, etc.

The Globe Carbon Company, of Cleveland, O., offer to the trade a carbon of superior longevity, the quality of whose light is not deteriorated by reason of the length of life of the carbon. Consumers are reminded that all the carbons manufactured by the Globe Company are guaranteed. A trial of the Globe carbons is solicited.

The Partz Electric Battery Company, of Philadelphia, having found their old quarters at 1,723 Chestnut street too small, have leased the large building at 636 Arch street, same city. They are now prepared to fill all orders promptly, and in addition to their large line of Open Circuit and Gravity and Motor Batteries, have a full line of small Motors and Dynamos. Send for their price list and catalogue, or write to them stating what you want.

Owing to the pressure on our columns this week, the Departments and the Patent Record are omitted.